PB-244 912

WATER QUALITY INVESTIGATIONS IN THE SOUTH PLATTE RIVER BASIN, COLORADO, 1971-72

National Field Investigations Center
Denver, Colorado

June 1972

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

267007

PB 244 912

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

PB244912

BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No.

4. Title and Subtitle
Water Quality Investigations in the South Platte River Basin, Colorado 1971-72

5. Report Date
June 1972

6.

7. Author(s)

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
National Field Investigations Center, Denver
and
Region VIII Denver, Colorado

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
Environmental Protection Agency
Office of Enforcement
Washington, D.C. 20460

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstracts

A comprehensive water quality investigation in the South Platte River Basin was conducted by the National Field Investigations Center-Denver (NFIC-D), EPA Office of Enforcement. The objectives of the studies were to define water quality conditions in the South Platte River, to evaluate water pollution abatement practices, to evaluate progress toward compliance with the 1966 Conference in the Matter of Pollution of the South Platte River Basin, to determine whether Colorado Water Quality Standards have been violated, and to determine the need for abatement proceedings. Only the technical aspects of pollution are summarized although the studies document technical, legal & institutional problems related to the water quality conditions of the South Platte River Basin.

17. Key Words and Document Analysis. 17a. Descriptors
*Water quality, *Stream pollution, water pollution - industrial wastes
* Nutrient pollution

17b. Identifiers/Open-Ended Terms
* South Platte River Basin, Colorado, Water quality standards

17c. COSATI Field/Group

18. Availability Statement
Release unlimited

Reproduced by
NATIONAL TECHNICAL INFORMATION SERVICE
US Department of Commerce
Springfield, VA 22151

19. Security Class (This Report)
UNCLASSIFIED

20. Security Class (This Page)
UNCLASSIFIED

21. No. of Pages
226

22. Price
8.50

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT

Report on

WATER QUALITY INVESTIGATIONS IN THE SOUTH PLATTE RIVER BASIN, COLORADO

1971 - 72

NATIONAL FIELD INVESTIGATIONS CENTER - DENVER

and

REGION VIII DENVER, COLORADO

June 1972

1a

TABLE OF CONTENTS

Page

LIST OF APPENDICES ii

LIST OF FIGURES iii

LIST OF APPENDICES TABLES vi

GLOSSARY OF TERMS xi

I. INTRODUCTION 1

A. Studies Prior to 1970 1
B. Water Quality Investigations 1971-72 2

II. SUMMARY AND CONCLUSIONS 5

III. DESCRIPTION OF THE STUDY AREA 17

A. Physical Description 17
B. Climate 20
C. Hydrology 21
D. Population and the Economy 22

IV. STREAM SURVEYS 25

A. Bear Creek 25
B. Clear Creek 26
C. Boulder Creek 28
D. St. Vrain Creek 30

Summer Survey (September 7-10, 1971) 30
Fall Survey (December 6-10, 1971) 32

E. Little Thompson River 33

Summer Survey (September 7-10, 1971) 33
Fall Survey (December 6-10, 1971) 35

F. Big Thompson River 36

Summer Survey (September 7-10, 1971) 36
Fall Survey (December 6-10, 1971) 38

TABLE OF CONTENTS (continued)

Page

G. Cache la Poudre River 39

Summer Survey (September 13-16, 1971) 39
Fall Survey (December 6, 7 and 13-15, 1971) . . 42

H. South Platte River 45

Summer Survey (August 30-September 6, 1971) . . 45
Fall Survey (November-December 1971) 54

VI. WASTE SOURCE EVALUATIONS 65

A. South Platte River and Tributaries - Waterton to Platteville 65
B. St. Vrain Creek Basin 69
C. Big Thompson River Basin 70
D. Cache la Poudre River Basin 71
E. South Platte River - Fort Morgan to the State Line 72

REFERENCES 73

APPENDICES

A WATER QUALITY STANDARDS FOR COLORADO AND NEBRASKA A-1

B LIST OF STREAM STATIONS B-1

C STUDY METHODS C-1

D CHEMICAL AND ANALYTICAL RESULTS FOR STREAM SURVEYS D-1

E BACTERIOLOGICAL RESULTS E-1

F AQUATIC GROWTHS F-1

G BENTHOS G-1

H FISH H-1

I DATA FOR WASTE SOURCE EVALUATIONS I-1

LIST OF FIGURES

Figure No.	Title	Follows Page
1	Location Map Water Quality Investigation, South Platte River Basin 1971	18
2	Sampling Location - South Platte River Basin Water Quality Investigations, Waterton to Henderson (1971)	26
3	Sampling Locations - South Platte River Basin Water Quality Investigations, Henderson to Kersey (1971)	26
4	Sampling Locations - South Platte River Basin Water Quality Investigations, Weldona to Nebraska State Line (1971)	26
5	Bacterial Densities, Bear Creek, Colorado August-September 1971	26
6	Populations of Benthic Invertebrates, Bear Creek, Colorado September 1971	26
7	Populations of Benthic Invertebrates Clear Creek, Colorado September 1971	26
8	Bacterial Densities, Clear Creek Colorado August-September 1971	28
9	Bacterial Densities, Boulder Creek, Colorado September 1971	28
10	Populations of Benthic Invertebrates St. Vrain and Boulder Creeks, Colorado September 1971	30
11	Bacterial Densities, St. Vrain Creek, Colorado September 1971	32

LIST OF FIGURES (continued)

Figure No.	Title	Follows Page
12	Populations of Benthic Invertebrates, Big Thompson and Little Thompson Rivers, Colorado September 1971	34
13	Bacterial Densities, Little Thompson River, Colorado September 1971	34
14	Bacterial Densities, Big Thompson River, Colorado September 1971	38
15	Populations of Benthic Invertebrates, Cache la Poudre River, Colorado September 1971	40
16	Bacterial Densities, Cache la Poudre River, Colorado September 1971	42
17	Attached Algae (chlorophyll a) Cache la Poudre River, Colorado 1966 and 1971	42
18	Attached Algae (cells/in^2) Cache la Poudre River, Colorado 1966 and 1971	42
19	Fish Populations, Cache la Poudre River, Colorado 1966 and 1971	42
20	Periphyton from Glass-Slide Substrates - Cache la Poudre River at Greeley, Colorado November 1971	44
21	Populations of Benthic Invertebrates, South Platte River (Waterton to Brighton)	46

LIST OF FIGURES (continued)

Figure No.	Title	Follows Page
22	Benthos and Suspended Solids, Waterton to Bowles Avenue, South Platte River, Colorado 1966 and 1971	46
23	Fish Populations and Suspended Solids, Waterton to Bowles Avenue, South Platte River, Colorado 1966 and 1971	46
24	Bacterial Densities, South Platte River from Water to Kersey, Colorado September 1971	50
25	Populations of Benthic Invertebrates South Platte River (Brighton to Kersey)	52
26	Periphyton from Glass-Slide Substrates, South Platte River at Brighton, Colorado November 1971	56
27	Extracted Chlorophyll α-Volatile Solids Ratio from Glass-Slide Substrates - South Platte River at Brighton, Colorado November 1971	56
28	Periphyton from Glass-Slide Substrates - South Platte River at Fort Morgan, Colorado November 1971	60
29	Periphyton from Glass-Slide Substrates - South Platte River at Sterling, Colorado November 1971	60
30	Periphyton from Glass-Slide Substrates - South Platte River, Colorado-Nebraska State Line November 1971	62

LIST OF APPENDICES TABLES

Table No.	Title	Page
A-1	Stream Classifications, South Platte River Basin, Colorado	A-13
B-1	Stream Sampling Locations in the South Platte River Basin, 1971	B-1
D-1	Summary of Field Measurements and Chemical Data for Stream Surveys on Tributaries in the Denver Metropolitan Area - Bear Creek, Cherry Creek, Sand Creek, and Clear Creek August 30-September 2, 1971	D-1
D-2	Summary of Field Measurements and Chemical Data at Selected Stations on St. Vrain and Boulder Creeks September 7-10, 1971	D-2
D-3	Summary of Field Measurements and Chemical Data at Selected Stations on St. Vrain Creek, December 6-10, 1971	D-3
D-4	Summary of Field Measurements and Chemical Data at Selected Stations on the Big and Little Thompson Rivers, September 7-10, 1971	D-4
D-5	Summary of Field Measurements and Chemical Data at Selected Stations on the Big and Little Thompson Rivers, December 6-10, 1971	D-5
D-6	Summary of Field Measurements and Chemical Data at Selected Stations on the Cache la Poudre River, September 13-16, 1971	D-6
D-7	Summary of Field Measurements and Chemical Data at Selected Stations on the Cache la Poudre River December 6-7, and 13-15, 1971	D-7

LIST OF APPENDICES TABLES (continued)

Table No.	Title	Page
E-5	Summary of Bacteriological Analyses at Selected Stations on the Big and Little Thompson Rivers, December 6-10, 1971	E-8
E-6	Summary of Bacteriological Analyses at Selected Stations on the Cache la Poudre River, December 6-7 and 13-15, 1971	E-9
E-7	Summary of Bacteriological Analyses at Selected Stations on the South Platte River, November 17-21, 1971	E-10
E-8	Summary of Bacteriological Analyses at Selected Stations on the South Platte River from Brighton Downstream to Kersey, December 6-15, 1971	E-11
E-9	Summary of Bacteriological Analyses at Selected Stations on the South Platte River from Upstream of Ft. Morgan to I-80 Bridge in Nebraska, November 29-December 3, 1971	E-12
F-1	Aquatic Growths from Glass-Slide Substrates, Cache la Poudre River Ten Day Exposure, Recovered in September 1971	F-1
F-2	Aquatic Growths from Glass-Slide Substrates, South Platte River Basin, Colorado, 14-Day Exposure Recovery in Novermber 1971	F-2
G-1	Benthos, Bear Creek, Colorado, August 30, 1971 (Numbers per square foot)	G-1
G-2	Benthos, Clear Creek, Colorado, August 30, 1971 (Numbers per square foot)	G-3
G-3	Benthos, Boulder Creek, Colorado, September 7, 1971 (Numbers per square foot)	G-5

LIST OF APPENDICES TABLES (continued)

Table No.	Title	Page
G-4	Benthos, St. Vrain Creek, Colorado, September 9, 1971 (Numbers per square foot)	G-8
G-5	Benthos, St. Vrain Creek, Colorado, November 29, 1971 (Numbers per square foot)	G-11
G-6	Benthos, Little Thompson River, Colorado, September 8, 1971 (Numbers per square foot)	G-12
G-7	Benthos, Little Thompson River, Colorado, November 29, 1971 (Numbers per square foot)	G-13
G-8	Benthos, Big Thompson River, Colorado, September 8, 1971 (Numbers per square foot)	G-14
G-9	Benthos, Big Thompson River, Colorado November 29, 1971 (Numbers per square foot)	G-17
G-10	Benthos, Cache la Poudre River, Colorado, September 13, 1971 (Numbers per square foot)	G-19
G-11	Benthos, Cache la Poudre River, Colorado, November 30, 1971 (Numbers per square foot)	G-22
G-12	Benthos, South Platte River and Selected Tributaries, Colorado, Collected in August, September, and October 1971 (Numbers per square foot)	G-23
G-13	Benthos, South Platte River, Colorado, Collected November 29 and 30, 1971 (Numbers per square foot)	G-27
H-1	Fish Captured Per Unit of Effort, Bear Creek, Colorado, September 1971	H-1

LIST OF APPENDICES TABLES (continued)

Table No.	Title	Page
H-2	Fish Captured Per Unit of Effort, Clear Creek, Colorado, September 1971	H-2
H-3	Fish Captured Per Unit of Effort, Boulder Creek, Colorado, September 1971	H-3
H-4	Fish Captured Per Unit of Effort, St. Vrain Creek, Colorado, September 1971	H-4
H-5	Fish Captured Per Unit of Effort, Big Thompson River, Colorado, September 1971	H-5
H-6	Fish Captured Per Unit of Effort Cache la Poudre River, Colorado, September and October 1971	H-6
H-7	Fish Captured Per Unit of Effort, South Platte River, Colorado, August and September 1971	H-8
I-1	Summary of Analytical Data for Industrial Waste Source Evaluations, South Platte River Basin	I-1
I-2	Summary of Industrial Waste Sources in the South Platte River	I-3
I-3	Summary of Field Measurements and Analytical Results of Effluent Discharge from the Great Western Sugar Company Plants	I-6
I-4	Summary of Bacteriological Analyses on Sugar Beet Mill Discharges in the South Platte River Basin, November-December 1971	I-9
I-5	Summary of Waste Treatment for the Great Western Sugar Plants in the South Platte River Basin, November-December 1971	I-11

LIST OF APPENDICES TABLES (continued)

Table No.	Title	Page
I-6	Summary of Analytical Data for Municipal Waste Source Evaluations - South Platte River Basin, August 1971 - February 1972	I-15
I-7	Summary of Bacteriological Analyses on Municipal Waste Treatment Plant Discharges in the South Platte River Basin, August and September 1971	I-20
I-8	Summary of Bacteriological Analyses of Selected Municipal Waste Treatment Plant Discharges, South Platte River Basin Survey, November-December 1971	I-23
I-9	Summary of Bacteriological Analyses on Municipal Waste Treatment Plant Discharges in the South Platte River Basin, January-February 1972	I-24
I-10	Summary of Findings Municipal Waste Source Evaluations in the South Platte River Basin, August 1971-February 1972	I-25

GLOSSARY OF TERMS

BOD - Biochemical Oxygen Demand, 5-Day

COD - Chemical Oxygen Demand

DO - Dissolved Oxygen

MPN - Most Probable Number

NH_3N - Ammonia Nitrogen

NO_2-NO_3-N - Nitrite Nitrate Nitrogen

P - Phosphorus

PO_4 - Orthophosphate

SS - Suspended Solids

TOC - Total Organic Carbon

RM - river mileage measured from stream mouth. Multiple numbers (e.g. 311.1/6.7) denote distance from junction of North and South Platte River to confluence with a tributary stream and second value indicating distance upstream from mouth of tributary stream

cfs - flow rate given in cubic feet per second

gpm - flow rate given in gallons per minute

mgd - flow rate given in million gallons per day

mg/l - concentration given in milligrams per liter

μmhos/cm - unit of specific conductance (mho -- the inverse of the standard unit of electrical resistance, the ohm) measured over a 1-centimeter distance, conventionally made at 25°C

Municipal waste - combination of domestic and industrial wastewaters discharged to waterways by governmental units, such as cities or sanitary districts

Industrial waste - spent process waters discharged to waterways by industries.

Agricultural waste - irrigation return waters, feedlot drainage, and erosion (Commodity wastes, such as sugar, meat, and canned produce, are considered as industrial or municipal wastes, based upon disposal jurisdiction.)

I. INTRODUCTION

A. STUDIES PRIOR TO 1970

Federal documentation of water pollution in the South Platte River Basin began in 1950.[1/] By 1963, it was apparent that water pollution was a serious problem affecting beneficial water uses at a number of locations in Colorado. At the request of the Governor of Colorado, the first session of the Conference in the Matter of Pollution of the South Platte River Basin (Colorado) was held on October 29, 1963, under the provisions of the Federal Water Pollution Control Act.[2/] As a result of this conference, a Federal-State study was initiated to define sources of pollution, delineate water quality conditions, and recommend appropriate abatement measures. The South Platte River Basin Project was formed to provide the Federal technical staff for carrying out the study.

From 1963 to 1966, the Project, in cooperation with the State of Colorado, conducted studies of various aspects of the pollution problem in the Basin and published a total of 13 technical reports. Results of the studies indicated that the principal water pollution problems were lack of adequate treatment for municipal and industrial waste discharges; bacterial contamination of surface streamflow and irrigation supplies; high organic loadings in some stream reaches, resulting in severe dissolved oxygen depletion; contamination of subsurface water supplies by municipal and industrial wastes; and a severe odor problem at Barr Lake. Both water quality objectives to protect beneficial water uses and pollution abatement measures to meet these objectives were set forth in the reports.

On April 27, 1966, a second session of the enforcement conference was held to review the progress that had been made in abating pollution.[3] The Project recommendations concerning water quality objectives and abatement measures were presented to the Conferees.[4] The session was adjourned, without formulating recommendations, in order to allow the newly formed Colorado Water Pollution Control Commission time to review these recommendations.

At a reconvened second session held on November 10, 1966, the Conferees agreed that "all discharges into the South Platte River shall have adequate remedial or control facilities in full operation by June 30, 1971, so as to comply with water quality standards [to be] established by the Colorado Water Pollution Control Commission as approved by the Secretary of the Interior".[5]

Water quality standards were established by the Commission and approved as Federal standards [Appendix A]. No additional sessions of the Conference have been held. Thus, the recommendations of the reconvened second session are the present conference requirements for pollution abatement. Since 1966 no basin-wide water quality investigations have been conducted to evaluate the status of compliance with the Conference recommendations.

B. WATER QUALITY INVESTIGATIONS 1971-72

In 1971 the Enforcement Division, Region VIII, Environmental Protection Agency (EPA), Denver, Colorado, requested the National Field Investigations Center-Denver (NFIC-D), EPA Office of Enforcement, to conducte a comprehensive water quality investigation in the South Platte River Basin.

The basin-wide water quality studies began in August 1971 and were completed in February 1972. Objectives of these studies were:

1. To define water quality conditions in the South Platte River and its principal tributaries and resultant effects on aquatic life and other beneficial water uses;
2. To evaluate water pollution abatement practices and abatement needs at municipal and industrial waste sources and to determine the effects of waste discharges from these sources on receiving waters;
3. To evaluate progress toward compliance with the 1966 Conference recommendations;
4. To determine whether Colorado Water Quality Standards have been violated;
5. To determine the need for abatement proceedings.

Studies were conducted in an area including the South Platte River and its principal tributaries from the Metropolitan Denver area downstream to the Colorado-Nebraska state line. Physical, chemical, and biological parameters were evaluated for major stream reaches. Municipal and industrial waste sources were inventoried and studied to characterize waste loads and to evaluate the effectiveness of waste treatment.

Although these studies document technical, legal, and institutional problems related to the water quality conditions in the South Platte River Basin, only the technical aspects of pollution are summarized in this report. Water quality and biological conditions observed during the stream survey are discussed in Section V. Water quality standards established by Colorado and Nebraska for the South Platte River and its tributaries are summarized in Appendix A. Sampling locations and study methods are discussed in Appendices B and C, respectively. Physical, chemical, bacteriological, and biological data are presented in Appendices D through H. Waste source evaluations and pollution abatement needs are discussed in Section VI. Waste source data are summarized in Appendix I as well as proposed waste load limitations for major industrial waste discharges.

Additional information on the studies is contained in the following reports entitled:

1. *Effects of Waste Discharges on Water Quality of South Platte River - Denver Metropolitan area. June 1972.*
2. *Technical Appendix on Municipal Waste-Source Evaluations, Water Quality Investigation in the South Platte River Basin Colorado 1971-72. June 1972.*
3. *Technical Appendix on Industrial Waste-Source Evaluations, Water Quality Investigations in the South Platte River Basin Colorado 1971-72. June 1972.*
4. *Investigations of the Effects of the Waste Discharges from the Great Western Sugar Mill at Ovid, Colorado, on Water Quality Conditions of the South Platte River. June 1972.*
5. *Effects of Waste Discharges on Water Quality of the Cache la Poudre and South Platte Rivers - Greeley Area. June 1972.*

Technical information contained in the latter two reports was used as a basis for informal public hearings regarding the 180-day notices issued by the Environmental Protection Agency to the Great Western Sugar Company for its mills at Greeley and Ovid, Colorado pursuant to Section 10(c)(5) of the Federal Water Pollution Control Act. The hearings were held on March 28 and 29, 1972, respectively.

II. SUMMARY AND CONCLUSIONS

1. Stream surveys were conducted in the South Platte River Basin, Colorado, during August, September, November, and December 1971. Bear Creek and Boulder Creek upstream of Coal Creek, St. Vrain Creep upstream of Longmont, and the South Platte River upstream of the Littleton, Colorado, waste discharge, have better water quality than was observed during the South Platte River Basin Project studies in 1964-65, although still degraded by point- and area-pollution sources. In the reach of the South Platte River from the Littleton waste discharge downstream to the Metropolitan Denver Sewage Disposal District No. 1 Plant (Metro) discharge and in Clear Creek, from Wheatridge (Colorado) to its confluence with the South Platte River, water quality has improved since 1964-65; but the water quality remains degraded.

2. Water quality in Bear Creek, Clear Creek, Boulder Creek, St. Vrain Creek, Big Thompson River, Little Thompson River, and in the Cache la Poudre River as well as the South Platte River upstream of Denver, is acceptable for fisheries and all other uses -- with the exception of isolated reaches affected by pollutional sources.

3. The South Platte River from the Metro discharge to Fort Lupton (Colorado) is severely degraded by the organic pollutant load from the Denver Metro area. Water quality of Sand Creek at the mouth, Boulder Creek downstream from Coal Creek, the Little Thompson River downstream from Johnstown, and the Cache la Poudre River downstream from Greeley was found to be as polluted during the 1971 survey as during the 1964-65 surveys.

4. The results of the evaluations of twenty-three municipal wastewater treatment facilities made in November and December 1971 and January 1972 are as follows:

a. Providing 80 percent removal of BOD and adequate disinfection:

(1) Arvada
(2) Clear Creek Valley
(3) Fort Collins #2
(4) Fort Lupton
(5) Lyons

b. Less than 80 percent BOD removal:

(1) Metro
(2) Greeley
(3) Baker WSD
(4) Boulder #1
(5) Boulder #2
(6) Brighton
(7) Coors-Golden
(8) Englewood
(9) Fort Collins #1
(10) Fort Morgan
(11) Julesburg
(12) Littleton
(13) Longmont
(14) Loveland
(15) South Adams WSD
(16) South Lakewood
(17) Sterling
(18) Wheatridge

c. Inadequate disinfection:

(1) Metro
(2) Greeley
(3) Brush (no disinfection)
(4) Brighton
(5) Englewood
(6) Fort Collins #1
(7) Fort Morgan (no disinfection)
(8) Julesburg
(9) Longmont (inoperative)
(10) Loveland
(11) South Adams WSD
(12) Sterling
(13) Wheatridge

Since the time of this survey, Coors-Golden has expanded its facilities to provide at least 80 percent BOD removal; and expansion and modifications are underway or planned at the Brighton, Boulder #2 (75th Street), Greeley, Metro, South Lakewood, Englewood, and Fort Morgan waste treatment facilities.

5. Since the 1964-65 study the organic load from industrial wastes has been reduced from approximately 400,000 lb/day of BOD, measured in 1964-65, to approximately 52,500 lb/day, measured during the 1971 survey through either the connection to municipal systems or the construction of industrial wastewater treatment facilities. The processing of sugar beets is the largest single source of industrial pollution in the South Platte River Basin. The Great Western Sugar Company is providing the additional pollution control facilities needed to reduce their BOD load from the 341,600 lb/day measured in 1964-65 to 12,800 lb/day by the 1973-74 campaign. Improvements are presently being made at the Greeley, Ovid, Johnstown, Longmont, Fort Morgan, and Sterling beet-sugar factories. Proposed facilities at the Johnstown plant will require further evaluation to determine their effectiveness. Other industrial sources requiring additional pollution abatement, as determined from effluent sampling, are the Continental Oil Company and the Refinery Corporation of Commerce City and the Weld County By-Products Company and the Loveland Packing Company of Loveland. Although effluent sampling was not performed, additional pollution abatement is required for the Burlington-Northern Railroad, Inc., of Denver and the Floyd Haag Sand and Gravel Company of Loveland.

6. Water quality of Bear Creek has improved since 1965; the previously reported conditions of sewage odors and suspended fecal and organic particles were not found in 1971. Treated domestic sewage from the cities of Evergreen and Morrison and approximately 30 storm sewers discharge into the Creek. The stream from Morrison to the South Platte River confluence remains biologically enriched. This reach has been classified by the State of Colorado as a warm-water fishery and for irrigation use. Bear Creek [illegible] in compliance with approved water quality standards.

7. Cherry Creek receives pollutants from numerous sources in the Denver metropolitan area. The Creek, described as severely polluted by sewage in 1965, was moderately polluted by organic material in 1971. Although the Creek is not classified for specific uses, the water was contaminated by total- and fecal-coliform bacteria densities as high as 120,000 and 3,000 per 100 ml, respectively.

8. Sand Creek, at the confluence with the South Platte River, was severely polluted by sewage; contamination was shown by average total-coliform bacteria counts that exceeded 110,000 per 100 ml and fecal-coliform bacteria densities of 8,800 per 100 ml. This creek which carries municipal and industrial wastes and storm-water runoff has not been classified by the State of Colorado for specific uses. Sand Creek has unsightly, putrescent, and odorous bottom deposits; there was objectionable odor and turbidity in the water. These conditions are in violation of the Basic Standards applicable to all waters of Colorado.

9. Clear Creek at RM 18.7 was damaged by mine drainage, as evidenced by a toxic concentration of zinc (0.36 mg/l) and severely restricted

aquatic life. At RM 15.4 wastes were discharged into Clear Creek from the Adolph Coors Company treatment facility, which also treats domestic wastes from the City of Golden. These wastes, wastes from the Wheatridge and Baker Sanitary District waste treatment plants, and storm-water runoff contributed to the pollution of Clear Creek. From Golden to the mouth, the creek is classified for use as a potable water supply. Downstream from the Coors discharge at RM 14.1, the water was turbid and smelled of sewage. Unsightly, putrescent, and odorous sludge deposits blanketed portions of the stream bed. The creek contained an average fecal-coliform bacteria density of 5,800 per 100 ml. Dissolved oxygen concentrations ranged as low as 3.4 mg/l. These conditions are in violation of approved Water Quality Standards of Colorado.

In 1971, Clear Creek, from RM 10.4 to the mouth, contained higher dissolved oxygen concentrations and lower bacterial densities than it did in 1965. Although this lower reach showed improvement, it remained in violation of the Colorado Standards that prohibit sludge deposits.

10. Boulder Creek is classified by the State of Colorado for use as a warm-water fishery. The creek was polluted by wastes from the Pearl Street (RM 21.3) and 75th Street (RM 17.8) treatment plants in Boulder. In this reach the dissolved oxygen concentration ranged as low as 4.7 mg/l, and the water was murky and smelled of sewage. Sludge blanketed portions of the stream bed. These conditions are prohibited by approved Colorado Standards. From RM 14.2 to the mouth of Boulder Creek, Water Quality Standards were not violated. Coal Creek, which flows into Boulder Creek at RM 7.9, receives treated municipal wastes from Erie, Lafayette, and Louisville, and was polluted with respect to coliform bacteria.

11. Prior to the sugar-beet campaign St. Vrain Creek which is classified by the State of Colorado for industrial and irrigation uses was polluted by inadequately treated wastes from the Longmont Wastewater Treatment Plant. Sludge deposits, odors, and turbidity were observed. These conditions are prohibited by approved Colorado Water Quality Standards.

During the sugar-beet campaign wastes discharged from the Great Western Sugar Company mill, at RM 22.5, in combination with Longmont domestic wastes, severely polluted St. Vrain Creek. Dissolved oxygen concentrations ranged from 0.3 to 3.7 mg/l, violating the 3.0 mg/l criterion approved for this stream reach. Organic solids, partly composed of putrefying slimes, formed large sludge beds; these conditions also violated Colorado Standards.

12. Water quality of the Little Thompson River has not changed substantially since 1964. The stream receives wastes from a combination of sources including animal feedlot drainage, irrigation return water, unrestricted livestock watering in the river, and domestic wastes from the Berthoud Wastewater Treatment Plant. At RM 11.1 no violations occurred of approved Colorado Standards for water classified as industrial supply and for irrigation; however, damage was indicated by a sparse population of pollution sensitive invertebrates (7 percent) and fecal-coliform bacteria numbering 1,900 per 100 ml.

Municipal wastes discharges, both from Johnstown (RM 1.15) and Milliken (RM 0.6), and the discharge from the Great Western Sugar Company Monosodium Glutamate and Sugar Recovery Plant (RM 2.8) severely polluted the Little Thompson River downstream from Johnstown. The formation of sludge deposits; production of objectionable odor and turbidity; and the development of slime growths were in violation of the Colorado Water Quality Standards.

13. The Big Thompson River, from Loveland to the mouth, is classified by the State of Colorado for industrial and irrigation uses. In this reach the major source of pollution is inadequately treated wastes discharged from the Loveland Wastewater Treatment Plant (RM 24.5). One mile downstream, the water was trubid and smelled of sewage, and the stream bed was covered with organic sludge. These conditions are not in accordance with approved Colorado Water Standards. Although there are no bacterial standards for the river downstream from Loveland, fecal-coliform bacteria counts averaging 1,300 per 100 ml indicated contamination.

Additional waste sources include the Loveland Packing Company (RM 25.6) and seasonal discharges from the Great Western Sugar Company (RM 22.0). Great Western at Loveland has substantially improved its wastewater treatment since 1964, reducing the mill effluent BOD from 50,000 (510 mg/l) to 800 (13 mg/l) lb/day. At RM 16.5 water quality improved; no Standards violations occurred.

Inflow of the polluted waters of the Little Thompson River severely degraded the Big Thompson River from RM 7.0 to the mouth. The water was turbid and sludge deposits and slimes blanketed the river bed. This was a violation of Colorado Water Quality Standards. Contamination was also indicated by an average fecal-coliform bacteria density of 2,600 per 100 ml.

14. The State of Colorado has classified the Cache la Poudre River, from Fort Collins to Greeley, for use as a warm-water fishery. From

Greeley to the mouth the river is classified for industrial and irrigation uses. Principal waste sources discharging to the Cache la Poudre River include: the Fort Collins (RM 44.1 and 40.2) and Greeley (RM 5.3) wastewater treatment plants; and the Great Western Sugar Company mill at Greeley (RM 4.3). Since 1964 there has been a reduction in the waste loads discharged to the Cache la Poudre River. The Great Western mill at Windsor which formerly discharged 74,000 lb BOD day closed in 1966; the Eaton Great Western mill installed pollution control measures that reduced the BOD of its wastes from 20,800 lb/day in 1965 to 490 lb/day in 1971.

Downstream from Fort Collins the Cache la Poudre River was degraded by sewage. Summertime production of dense mats of algae constituted violations of approved Colorado Water Quality Standards. During the summer and fall of 1971 the river was severely polluted from RM 5.3 to the mouth. Inadequately treated wastes were discharged from the Greeley Wastewater Treatment Plant and the Great Western Sugar Company mill at Greeley. There is no bacteriological standard for this lower reach, but severe contamination was indicated by total- and fecal-coliform bacteria densities as high as 1,500,000 and 100,000 per 100 ml, respectively. The dissolved oxygen content of waters classified for industrial use must not be less than 3 mg/l. This standard was violated at RM 0.5 where concentrations ranged as low as 2.7 mg/l. Additional water-quality standards violations included the development of sludge banks and objectionable odors and turbidity in the water.

15. The State of Colorado has classified the South Platte River, from its headwaters to Exposition Avenue (RM 321.9) in Denver, for use as cold-water fishery. Major waste sources in this reach include the municipal treatment plants at Littleton (RM 327.6) and Englewood (RM 325.1). Other sources include storm-water runoff and minor discharges. No violations of the approved Colorado Water Quality Standards occurred in this reach.

The South Platte River, from Exposition Avenue to York Street (RM 313.4), is classified as a warm-water fishery. Waste sources include: numerous storm sewers; minor industrial discharges; South Lakewood Sanitation District; occasional bypassing from sanitary sewers and the inflow from Cherry Creek. Raw sewage which entered the South Platte River at 47th Avenue (RM 315.1) and at Franklin Street (RM 314.3) resulted in fecal-coliform bacteria densities that averaged more than 13,000 per 100 ml; sludge banks built up downstream from each of these discharges. These conditions were in violation of Colorado Water Quality Standards.

The South Platte River, from York Street to the Colorado-Nebraska State Line, is classified for industrial and irrigation uses. The major waste source in this reach is the Metro plant. Adequate treatment was not being provided by the Metro plant for BOD and suspended solids removal. The BOD removals ranged from 63 to 96 percent and were below the State requirement of 80 percent BOD removal 20 percent of the time. Suspended solids removal ranged between 39 and 95 percent. Adequate disinfection was not provided, as shown by the low chlorine residuals and the high bacteria densities in the effluent. Fecal-coliform bacteria densities in the effluent were as high as 430,000/100 ml. The Colorado Department of Health recommendation for a residual chlorine value of 1 mg/l after 15 minutes at maximum hourly flow was not maintained during the study.

The Denver Northside Waste Treatment Plant provides primary treatment prior to discharge to Metro. Wastes from the Northside plant constitute about 75 percent of the total hydraulic load and more than 70 percent of the organic load received by Metro. During the study-period the Denver Northside Waste Treatment Plant had BOD removal efficiencies ranging from minus 11 percent (an increase in BOD) to 58 percent and suspended solids removal efficiencies ranging from 6 percent to 96 percent. Inadequate primary treatment at Denver Northside significantly affects removal efficiencies at the Metro facility.

The Colorado Department of Health and EPA are working with the staff at the Denver Northside waste treatment plant to improve treatment methods at this plant, thereby reducing the wasteload contributed to the Denver Metro facility.

Official State-Federal Water Quality Standards in the South Platte River will not be met by the attainment of a minimum 80 percent removal of five-day BOD at the Metro facility. The South Platte River water quality criteria for dissolved oxygen could be met by the expansion of the Metro plant and improvement in plant operation in order to produce an average effluent of 10,000 lb/day of BOD with a maximum instantaneous limit equivalent to 15,000 lb/day. This average limit is equivalent to an effluent concentration of 10 mg/l and would require an estimated 95 percent BOD reduction, based on present influent values.

Other principal waste sources in the South Platte River, downstream from York Street, include: municipal discharges from South Adams

(RM 306.7), Brighton (RM 295.8), Fort Morgan (RM 195.2), Brush (RM 185.6), Sterling (RM 148.6), and Julesburg (RM 86.9); inflows from Sand Creek, Clear Creek, St. Vrain Creek, the Big Thompson River, and the Cache la Poudre River; and seasonal discharges from the Great Western Sugar Company mills at Brighton (RM 295.7), Fort Morgan (RM 196.2), Sterling (RM 150.4), and Ovid (RM 94.8).

At Henderson (RM 301.7), during the summer, the 3 mg/l dissolved oxygen standard was violated. From the Metro discharge (RM 312.2), downstream to Fort Lupton (RM 288.2), dissolved oxygen concentrations were often below 4 mg/l in the summertime, and sludge beds blanketed the stream bottom. Odor, turbidity, and the development of these sludge beds were in violation of the Colorado Standards.

During the sugar-beet campaign violations of the Colorado Standards occurred downstream from the Great Western Company mills at Fort Morgan, Sterling, and Ovid. Sludge banks and slime growths developed; odor and turbidity were imparted to the water. Although there are no bacteriological standards applicable to the South Platte River from York Street (RM 313.4) to the Colorado-Nebraska State Line (RM 83.7) severe contamination was indicated by fecal-coliform bacteria densities as high as 910,000 per 100 ml and by the presence of pathogenic *Salmonella*. Both Colorado and Nebraska bacterial criteria were grossly violated at the State Line by waste discharged from the Great Western mill at Ovid, Colorado.

The Colorado Water Pollution Control Commission is in the process of re-evaluating water quality standards for the South Platte River. Public hearings have been held concerning the establishment of effluent standards to enhance water quality in the South Platte River.

III. DESCRIPTION OF THE STUDY AREA

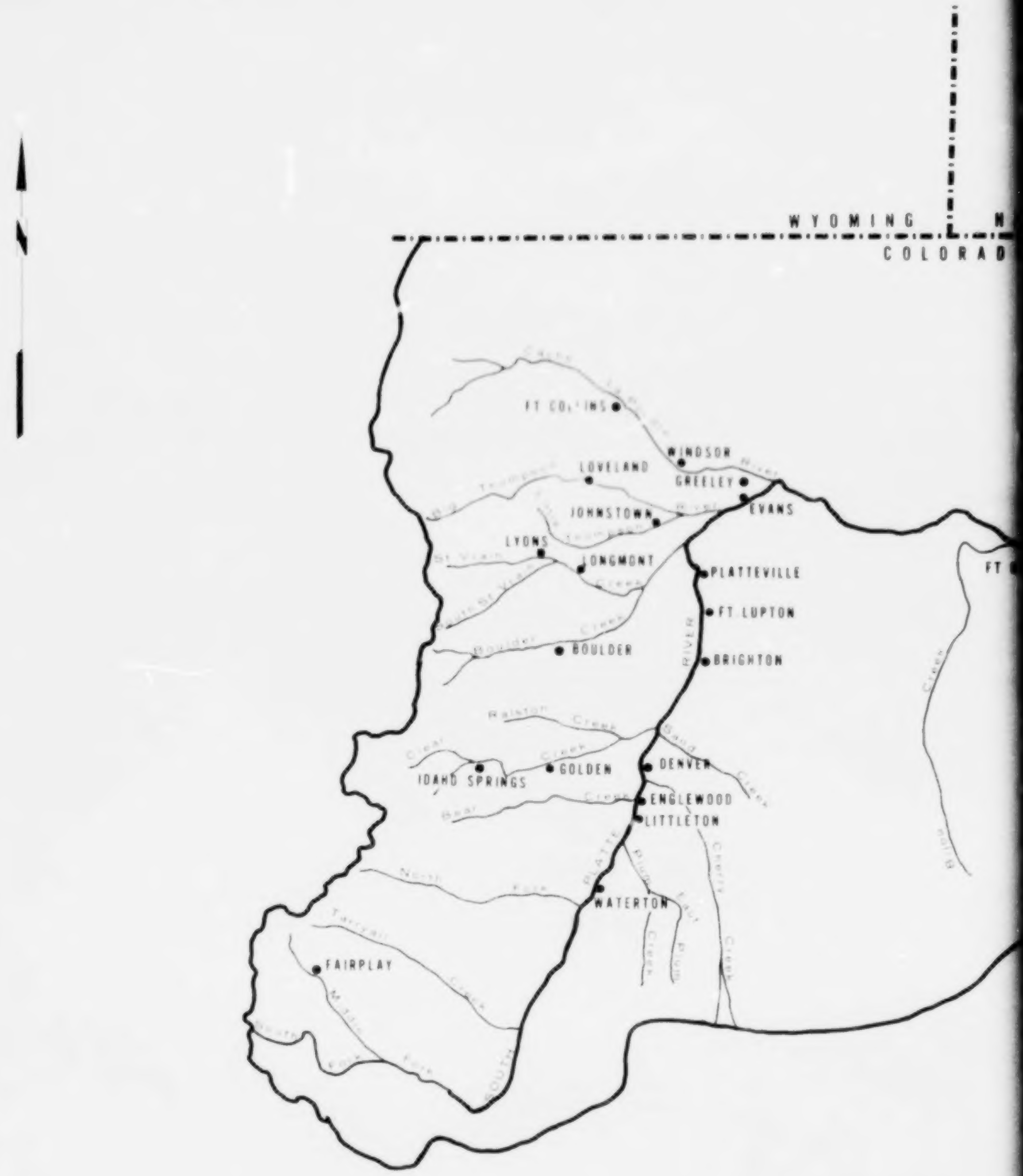
A. PHYSICAL DESCRIPTION

The South Platte River basin lies in northeastern Colorado, southeastern Wyoming, and southwestern Nebraska and is part of the headwaters of the Missouri River [Figure 1]. More than 80 percent of the Basin's 24,300 square miles are in Colorado. This report is concerned only with the South Platte River and its principal tributaries within Colorado.

The South Platte River, rising along the eastern slope of the Continental Divide, in areas northwest of Fairplay, flows south and then east across the broad area known as South Park and through Eleven Mile Canyon. Near Lake George the river flows northward through mountainous country to emerge from the foothills about 15 miles south-southwest of the Metropolitan Denver area and then to continue in a northward direction to the vicinity of Greeley. There, the river turns and follows an irregular east-northeast course, joining with the North Platte River at North Platte, Nebraska. The length of the river from its source to the mouth is approximately 442 miles.

The study area lies within two types of land formation, mountains and plains. In the mountainous areas, exposed bedrock or thin soil deposits bound the streams. The cool, crystal-clear headwaters are formed primarily from snow melt and rainfall runoff and contain a minimum of nutrients. Steep stream gradients (up to 1,000 feet per mile) cause the water to cascade over large boulders. The resulting turbulence not only helps maintain a desirable balance of dissolved gasses but also causes erosion. Dissolved materials are added to the stream in this process. Environmental conditions are adequate to support a variety of invertebrates, which are food for fish. Water quality is suitable for cold water fishery, including rainbow and brown trout. With the exception of stream reaches affected by mine drainage, water quality problems are minor. For this reason, the study area extended upstream only to the foothill reaches of the river and tributaries.

In the plains, channels of the river and lower reaches of tributaries cut through deep alluvial gravel and soil deposits. Sparse vegetation does not hold the soil so that erosion is common. Because of this condition there is rapid runoff; rain storms temporarily muddy the streams. Ground water seepage carries dissolved salts and nutrients leached from the soils into the stream. This increases the hardness and biological productivity in the river. Stream gradients in the plains area are from eight to twenty feet per mile and the water turbulence is thereby reduced. During the summer, low-water conditions prevail because of increased evaporation, lack of rainfall, and the various uses made of the river water (e.g. irrigation diversions). The shallow mainstream water and isolated pools are warmed by the sun. After rain storms, pooled water mixes with the main stream as the river rises and often increases the water temperature. Additionally, in these pools and elsewhere, organic materials accumulate. Decomposition of this organic matter alters the balance of dissolved gasses.

WYOMING
COLORAD
N
Cache la Poudre River
FT COLLINS
WINDSOR
LOVELAND
GREELEY
EVANS
Big Thompson River
Little Thompson
JOHNSTOWN
LYONS
LONGMONT
St Vrain Creek
South St Vrain
PLATTEVILLE
FT LUPTON
BRIGHTON
Boulder Creek
BOULDER
Ralston Creek
Clear Creek
IDAHO SPRINGS
GOLDEN
DENVER
Sand Creek
Bear Creek
ENGLEWOOD
LITTLETON
Cherry Creek
Plum Creek
East Plum
North Fork
WATERTON
Tarryall Creek
FAIRPLAY
Middle Fork
South Fork
SOUTH PLATTE RIVER
Bijou Creek
FT

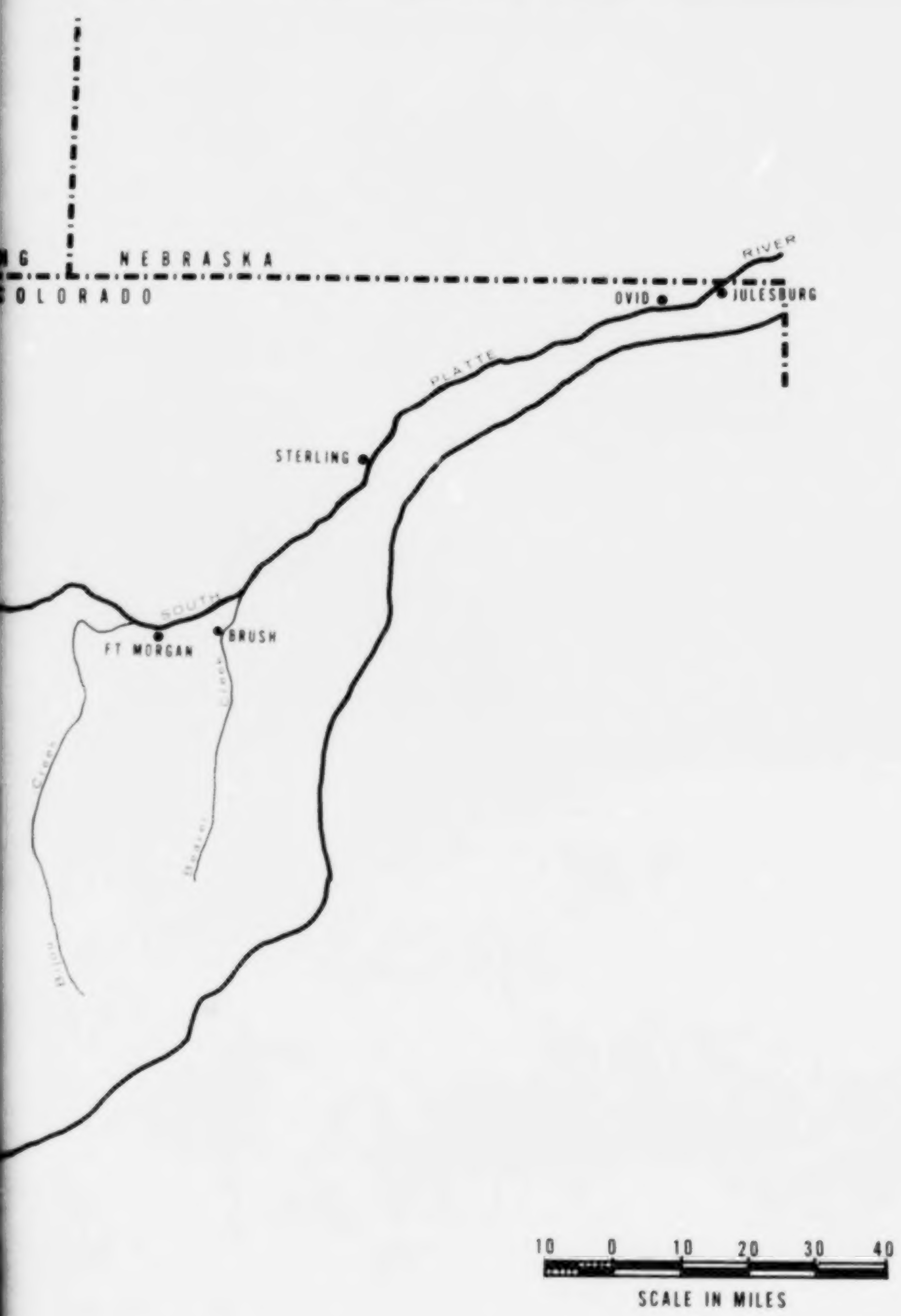


Figure 1 Location Map Water Quality Investigation, South Platte River Basin 1971

In combination, these conditions often cause a decrease in the invertebrate variety and an increase in the biological productivity. The waters of the plains are suitable for warmwater fishery which includes such gamefish as bass and catfish.

Water quality conditions in the plains streams are substantially affected by municipal and industrial waste discharges, feedlot drainage, irrigation return flows, and other agricultural activities. Irrigation diversions also exert a major influence on water quality. They reduce the stream flow available for assimilation of pollutants carried into the streams from the above sources. Water quality degradation is most severe downstream from urban areas.

Principal tributary streams in the study area, in downstream order, are: Bear, Clear, Boulder and St. Vrain Creeks, and the Big Thompson and Cache la Poudre Rivers. These streams originate along the Continental Divide and in drain areas similar in character to the watershed of the South Platte main stem.

Bear Creek, the uppermost principal tributary in the study area, flows northeastward past the towns of Evergreen and Morrison to join the South Platte at River Mile (RM) 326.4 in south Denver.

Clear Creek, whose water quality is influenced by old mining activities near the mountain communities of Central City and Idaho Springs, flows down from the mountains through Golden and enters the river at RM 311.1, in the northern part of Denver, downstream from the Metropolitan Denver Sewage Disposal plant.

Boulder Creek, a major tributary of St. Vrain Creek, flows easterly through the city of Boulder and across the southern portion of Boulder County. The creek enters the St. Vrain River 17.4 miles upstream of its confluence with the South Platte River.

The St. Vrain River rises from two small tributaries in the foothills of northwestern Boulder County. This creek flows easterly through the city of Longmont, then across the high plains of northern Boulder County into Weld County, and joins the South Platte at RM 270.

The Little Thompson River, a principal tributary of the Big Thompson River, arises in south-central Larimer County and flows eastward, passing through Boulder County, into Weld County, joining the Big Thompson River at RM 7.0. The latter stream flows easterly across the highlands of southern Larimer County into Weld County and joins the South Platte River at RM 260.4.

The northernmost and largest tributary to the South Platte River is the Cache la Poudre River. Its headwaters begin north of Rocky Mountain National Park, converge and flow northeast along the eastern slope of the Rocky Mountains. The river turns east, about 20 miles from the Colorado-Wyoming state line, and flows past the communities of Ft. Collins, Windsor, and Greeley, where it joins the South Platte River at RM 249.

B. CLIMATE

Climate in the study area is primarily a function of elevation and landform. Elevations in the main river valley range from about 3,500 feet above sea level near the eastern edge of the study area to about 5,000 feet at Denver. Foothills and mountain areas range between 6,500 and 11,000 feet with some mountain peaks reaching 14,000 feet.

The plains are characterized by low relative humidity, light rainfall, warm summers, mild winters, considerable wind, and large annual variations in precipitation. Mountain areas have lower temperatures and some snowfall. The foothill areas present a transitional climatological zone.

Precipitation is greatest in the mountain headwater areas, exceeding 30 inches per year. Downstream, the annual precipitation decreases to 15 inches in the foothills and to about 12 inches near Greeley and then increases again to about 19 inches at the lower end of the basin.

Temperature extremes range from -30 to 110°F. The frost-free period ranges from about 165 days in the Denver area to about 133 days in the northern plains.

C. HYDROLOGY

The primary source of water in the study area is runoff from melting snowpack. Numerous reservoirs have been constructed in the mountain and foothill areas to store this runoff. As a result, all of the principal streams in the study area are regulated to some degree. During the irrigation season diversions and return flows cause major changes in stream flow within relatively short stream reaches.

High intensity summer rainstorms may produce flash floods in the plains streams and several major floods have occurred in the Metropolitan Denver area.

The basin is a water short area and water use far exceeds the natural supply. Re-use of water is practiced in a number of areas, notably the use of portions of the treated waste effluent from the Metropolitan Denver area for irrigation purposes. The natural surface runoff in the basin averages about 1,244,000 acre-feet annually. An additional 500,000 acre-feet are imported annually from the Colorado River Basin, primarily by Denver for municipal and industrial purposes and by the Bureau of Reclamation Colorado-Big Thompson Project for irrigation uses. Extensive use of ground water is also made for irrigation in the plains areas.

D. POPULATION AND THE ECONOMY

Population growth in the basin has been rapid in recent years, with an increase of at least 52 percent occurring since 1960, mostly in urban areas. The Metropolitan Denver urban area population increased from 855,000 in 1960 to 1.3 million in 1970. Other urban areas and their 1970 populations are: Greeley, 38,900; Fort Collins, 45,000; Longmont, 23,200; Loveland, 16,200; and Boulder, 66,900.

The plains and mountain areas are sparsely populated. Most of the urban areas are concentrated along the eastern edge of the foothills.

Agriculture is the primary industry in the plains area. The production of crops is primarily dependent upon irrigation. The principal crops are alfalfa, small grains, corn, and sugar beets. Important agricultural related industries include sugar beet processing mills, livestock feedlots, meat packing plants, and canneries.

Mining and livestock grazing were historically the major industrial activities in mountain areas. Recreational land use including skiing, camping and hiking has recently achieved major importance.

The Metropolitan Denver area supports a large number of diverse industrial and related activities including aerospace; light manufacturing; electronics; computer and data processing; educational and scientific complexes; Federal and State government offices and laboratories; and the manufacturing of rubber products.

IV. STREAM SURVEYS

In August and September 1971 the South Platte River and its principal tributaries were studied from Waterton through the Denver metropolitan area downstream to Kersey, Colorado [Figures 2 and 3]. [A tabulation of the stream stations, analyses performed, and study methods are contained in Appendices B and C.] The data, presented in the sections titled Summer Survey, represent river conditions prior to the 1971 sugar beet campaign.

In November and December selected stations in the South Platte River and in the subbasins of St. Vrain Creek, Big Thompson River, and Cache la Poudre River within the State of Colorado were studied [Figures 2, 3 and 4]. Results are presented in the sections titled Fall Survey and represent river conditions during the 1971 sugar beet campaign.

A. BEAR CREEK

In the mountainous area near the community of Morrison (RM 13.0), Bear Creek had good water quality. The BOD averaged 2.5 mg/l [Appendix D, Table D-1] and the fecal-coliform bacteria log mean number was 720/100 ml of water [Figure 5]. The benthos consisted of 670 organisms/ft^2 [Figure 6], and were represented by 19 kinds. Rainbow trout comprised 14 percent of the total fish population of this reach [Appendix H, Table H-1].

Downstream, at RM 5.9, the waters of Bear Creek were fertilized by waste discharged from the Morrison area. An estimated 29 storm sewers and outfalls (of unknown origin) discharge to Bear Creek between Morrison and the mouth.[6/] The density of benthic organisms increased to 1,634/ft^2 [Figure 6] and diversity increased to 21 kinds by the addition of facultative and pollution-tolerant organisms [Appendix G, Table G-1].

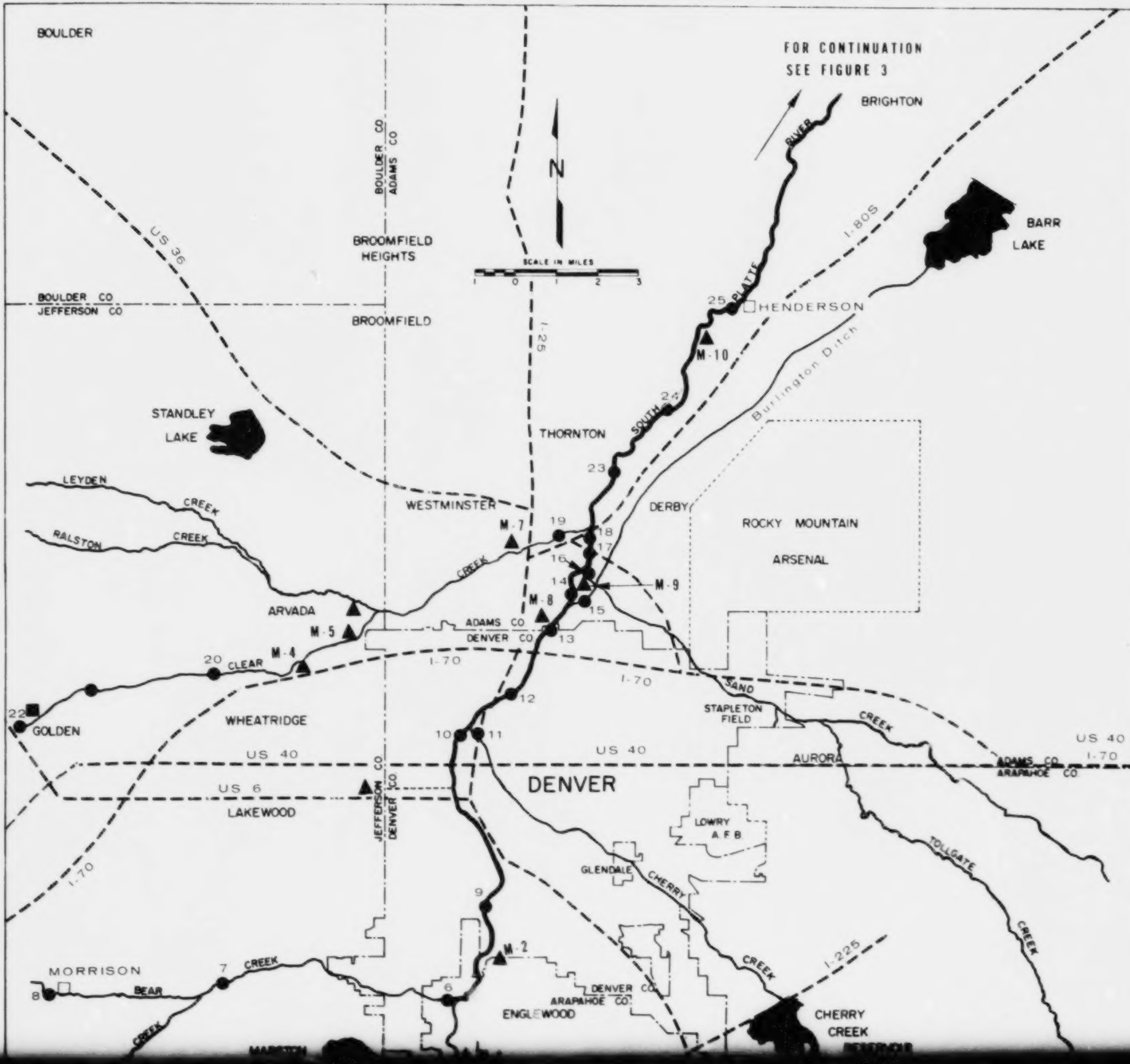
Wastes entering Bear Creek between RM 5.9 and 0.7 sustained the enriched conditions. Nutrients [Appendix D, Table D-1] in this reach stimulated the production of dense algal mats that caused DO levels to fluctuate between 5.7 and 11.3 mg/l at different times of the day. The variety of benthos was reduced to 16 kinds, mostly facultative and pollution-tolerant forms. Pollution-intolerant forms decreased from 67 percent, upstream at RM 5.9, to 11 percent at RM 0.7. Fish populations near the Bear Creek mouth consisted of non-game species.

The quality of Bear Creek waters has improved since 1964. The creek was enriched with nutrients from Morrison downstream to the South Platte River confluence. Bear Creek was, at the time of the survey, in compliance with approved water quality standards.

B. CLEAR CREEK

In the portion of Clear Creek immediately upstream of Golden (RM 18.7) the water contained little organic matter [Appendix D, Table D-1] and acceptably low numbers of bacteria [Appendix E, Table E-1]. Benthos consisted of only nine kinds of organisms; however, 84 percent of these were mayflies and caddisflies, forms intolerant of organic pollution, and pollution-tolerant forms numbered less than one percent of the benthos community [Figure 7]. The low density (112/ft^2) and restricted variety of benthic organisms probably resulted from the influence of mine drainage [Tables G-2 and D-12]. Fish populating this reach consisted of longnose suckers and brown trout in very low numbers.

The Coors wastewater treatment plant (domestic and industrial wastes) discharges to Clear Creek (RM 15.4). Analyses of the plant effluent during


FOR CONTINUATION
SEE FIGURE 3
BOULDER
BRIGHTON
N
SCALE IN MILES
1 0 1 2 3
BOULDER CO
ADAMS CO
BROOMFIELD HEIGHTS
BOULDER CO
JEFFERSON CO
BROOMFIELD
US 36
I-25
I-80S
BARR LAKE
RIVER
PLATTE
SOUTH
25
HENDERSON
M-10
24
Burlington Ditch
STANDLEY LAKE
THORNTON
23
LEYDEN
CREEK
RALSTON
CREEK
WESTMINSTER
DERBY
ROCKY MOUNTAIN
ARSENAL
M-7
19
18
17
16
14
15
M-9
M-8
CREEK
ARVADA
M-5
ADAMS CO
DENVER CO
13
M-4
20
CLEAR
I-70
I-70
SAND
12
22
GOLDEN
WHEATRIDGE
STAPLETON FIELD
CREEK
10
11
US 40
US 40
US 40
ADAMS CO
I-70
ARAPAHOE CO
AURORA
US 6
DENVER
LAKEWOOD
JEFFERSON CO
DENVER CO
LOWRY A F B
I-70
GLENDALE
CHERRY
TOLLGATE
9
CREEK
M-2
I-225
MORRISON
7
CREEK
BEAR
8
6
DENVER CO
ARAPAHOE CO
ENGLEWOOD
CREEK
CHERRY CREEK
CREEK

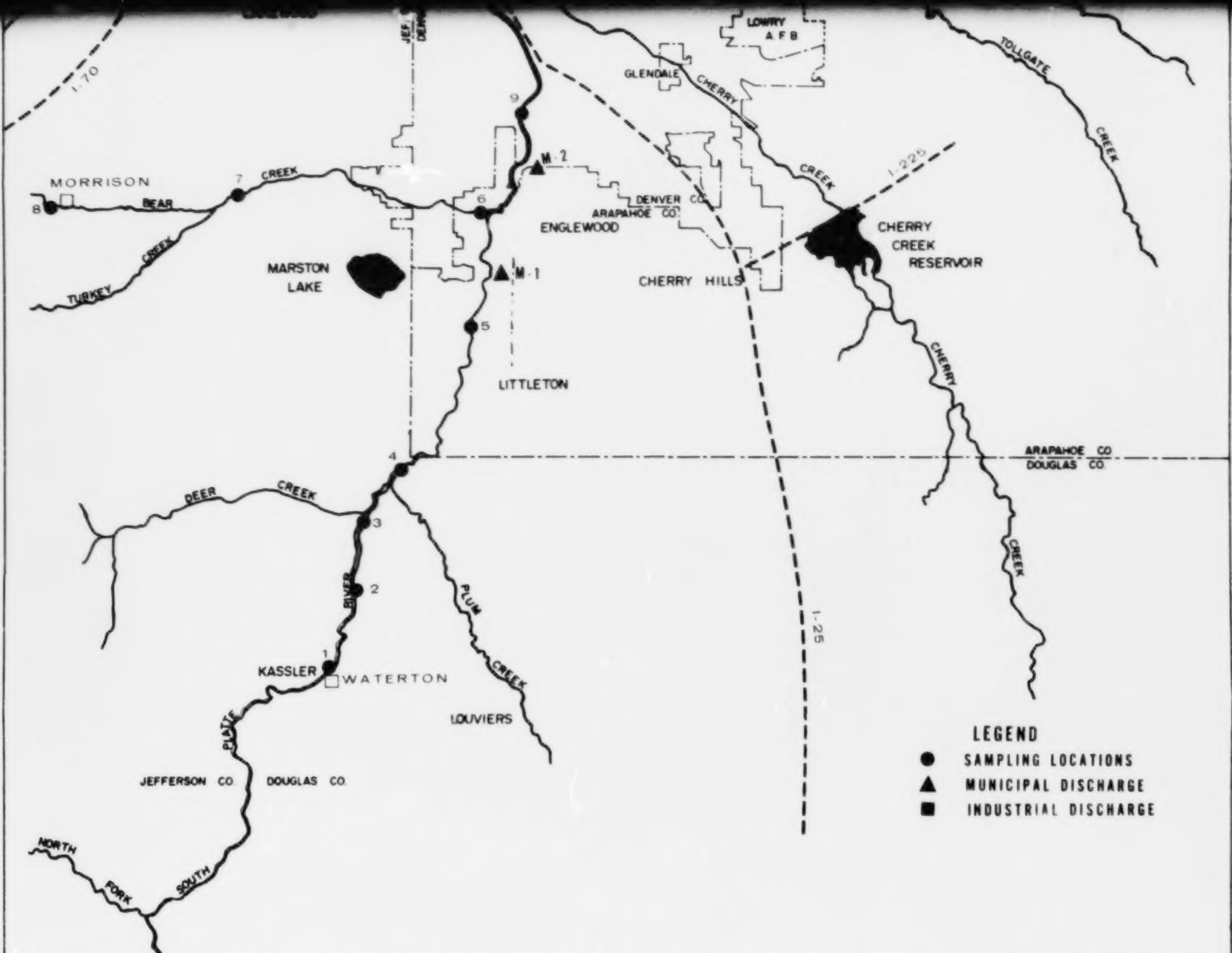
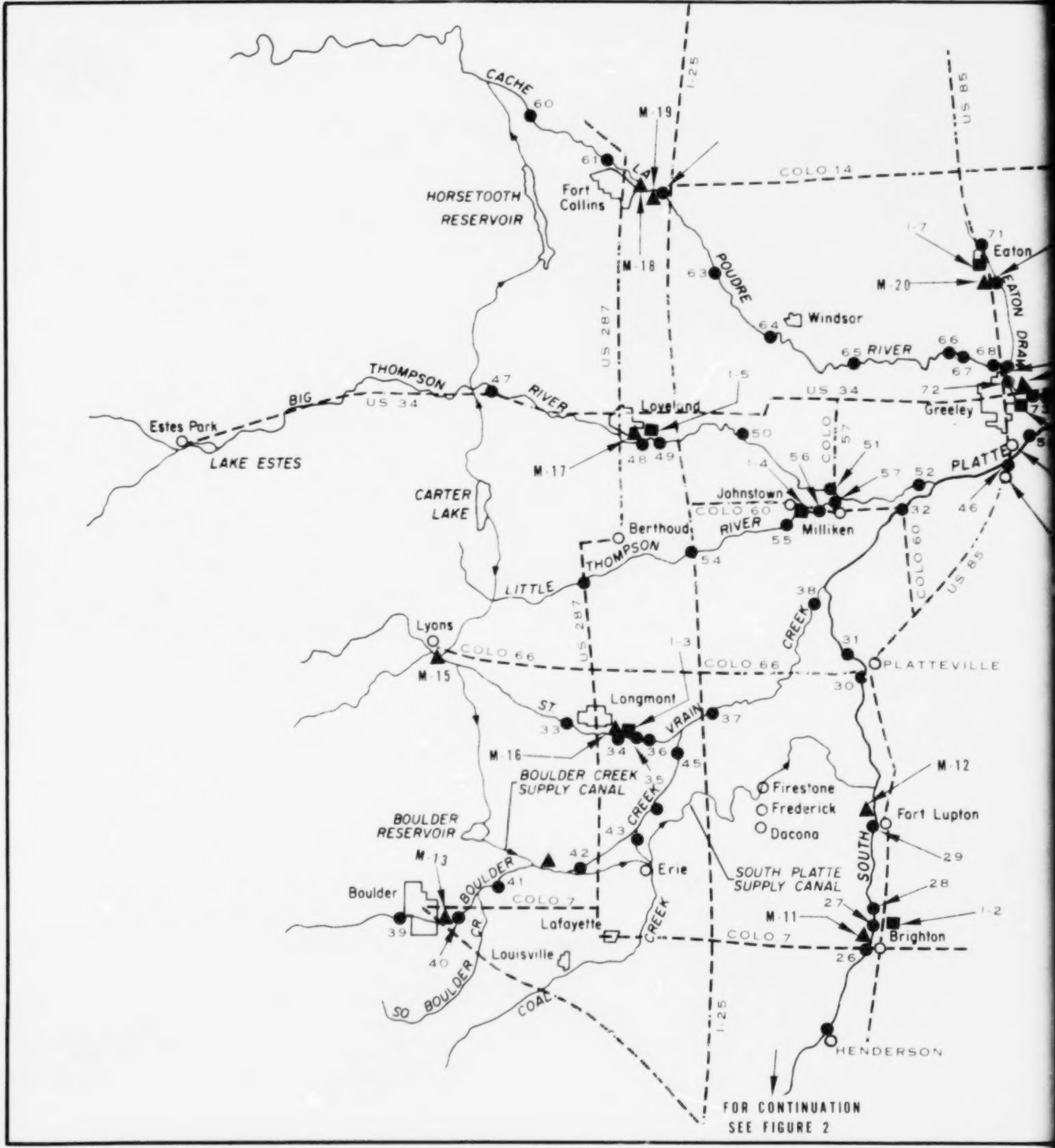


Figure 2 Sampling Locations-South Platte River Basin Water Quality Investigations. Waterton to Henderson (1971)



FOR CONTINUATION
SEE FIGURE 2

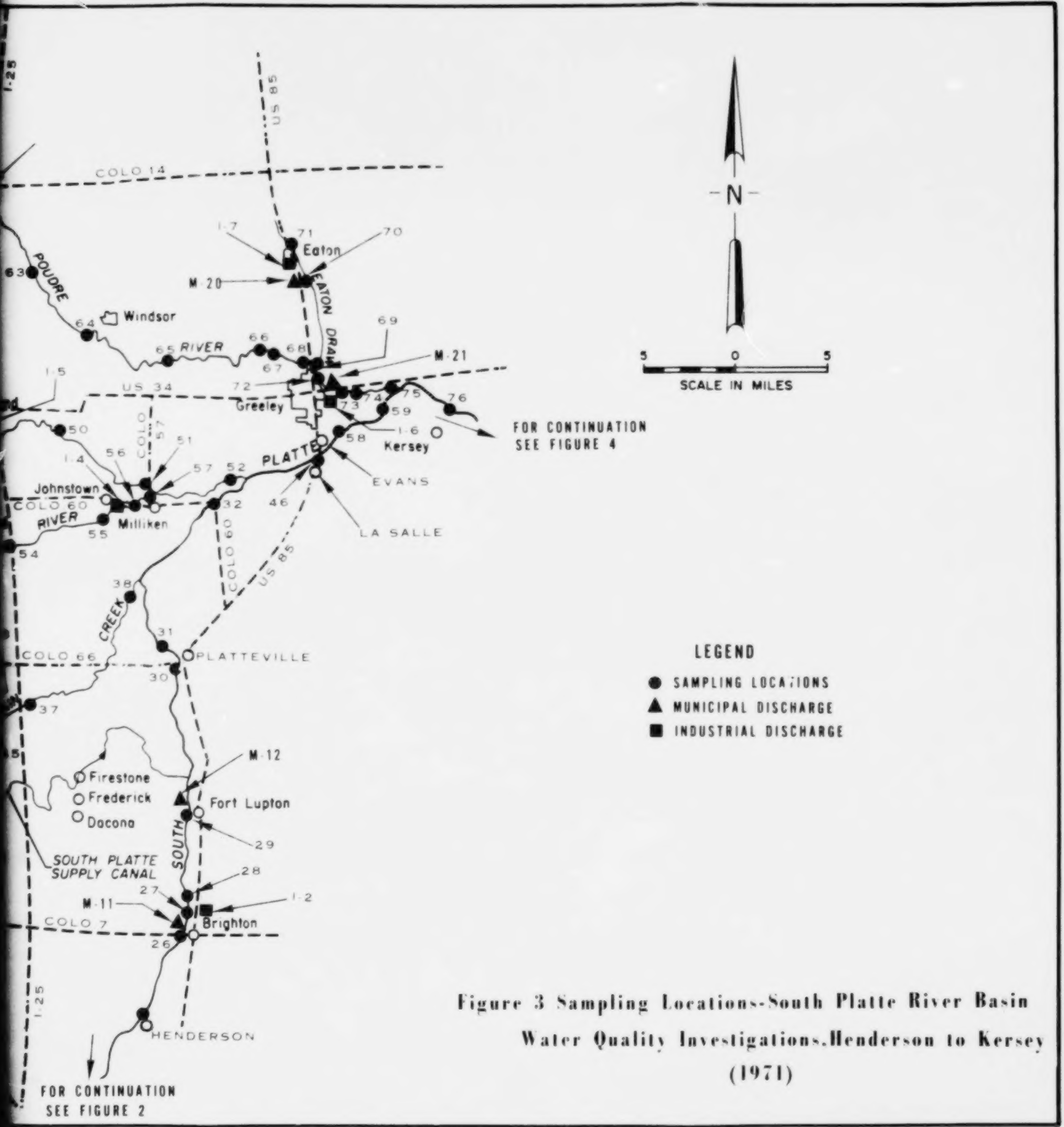
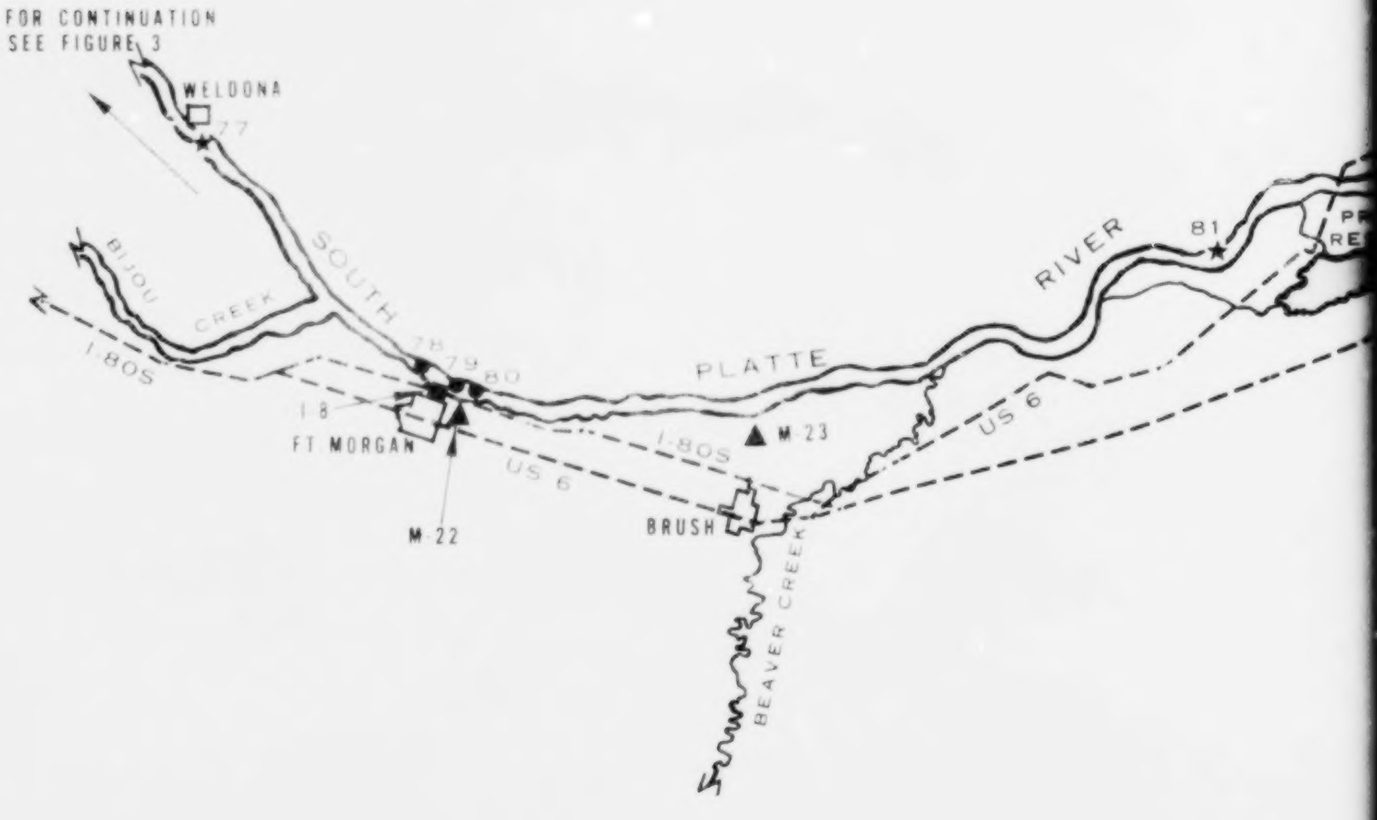
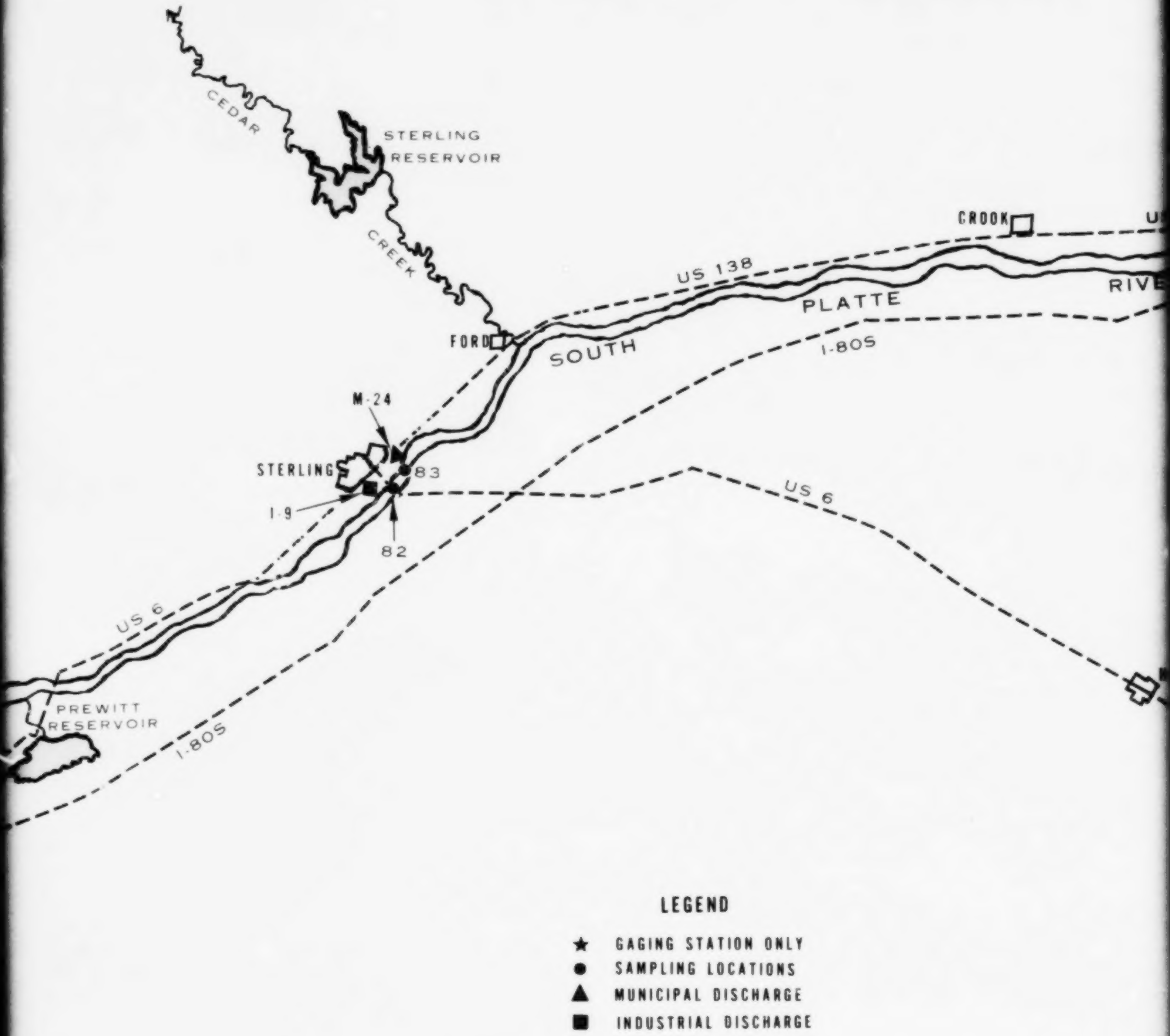


Figure 3 Sampling Locations-South Platte River Basin Water Quality Investigations, Henderson to Kersey (1971)


FOR CONTINUATION
SEE FIGURE 3
WELDONA
77
BIJOU CREEK
SOUTH
PLATTE
RIVER
I-80S
78
79
80
I-8
FT MORGAN
M-22
US 6
I-80S
M-23
BRUSH
BEAVER CREEK
US 6
81
PR
RE


CEDAR
CREEK
STERLING
RESERVOIR
CROOK
US 138
SOUTH
PLATTE
RIVE
FORD
I-80S
M-24
STERLING
83
I-9
82
US 6
US 6
PREWITT
RESERVOIR
I-80S
LEGEND
★ GAGING STATION ONLY
● SAMPLING LOCATIONS
▲ MUNICIPAL DISCHARGE
■ INDUSTRIAL DISCHARGE

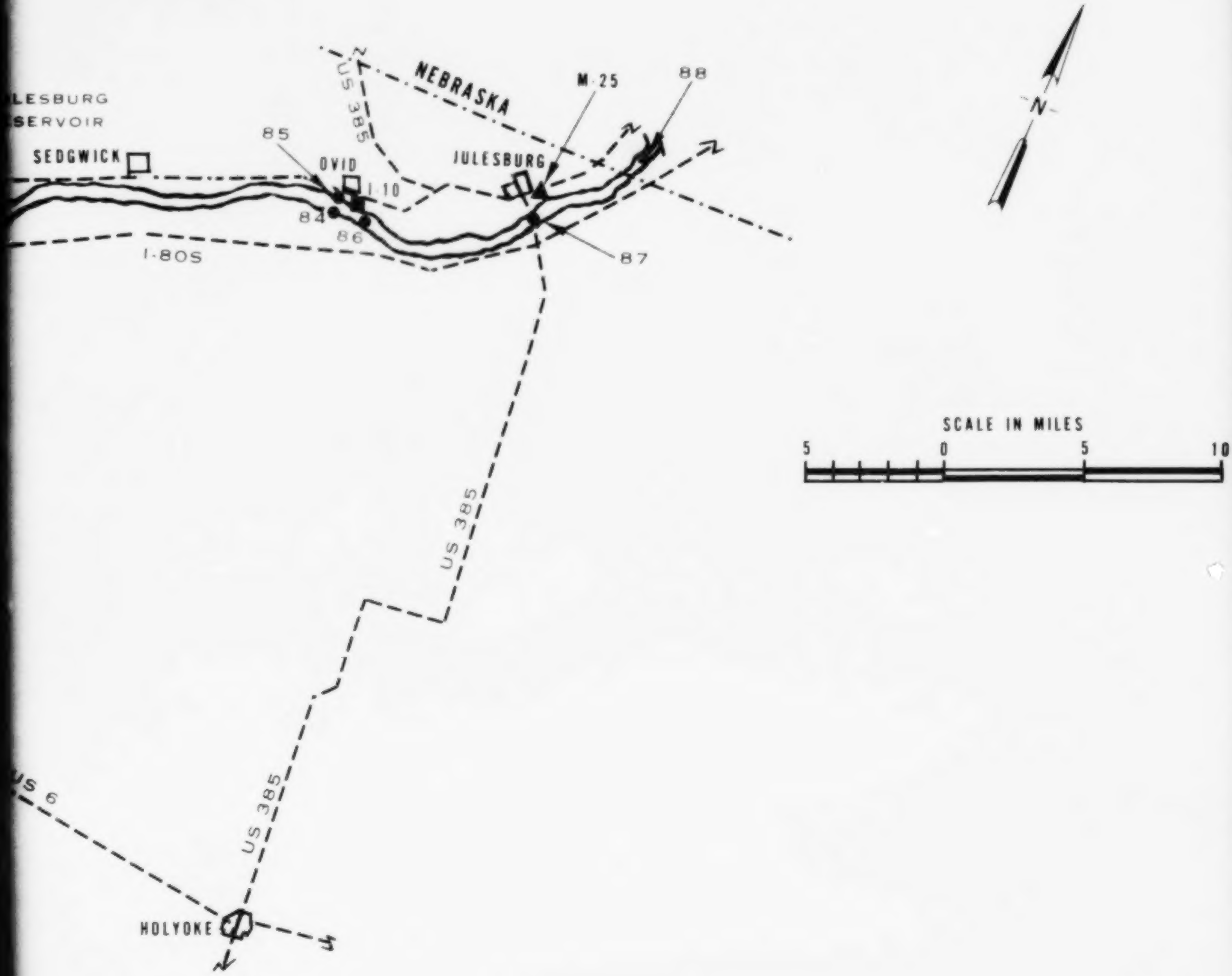


Figure 4 Sampling Locations-South Platte River Basin. Water Quality Investigations. Weldona to Nebraska State Line (1971)

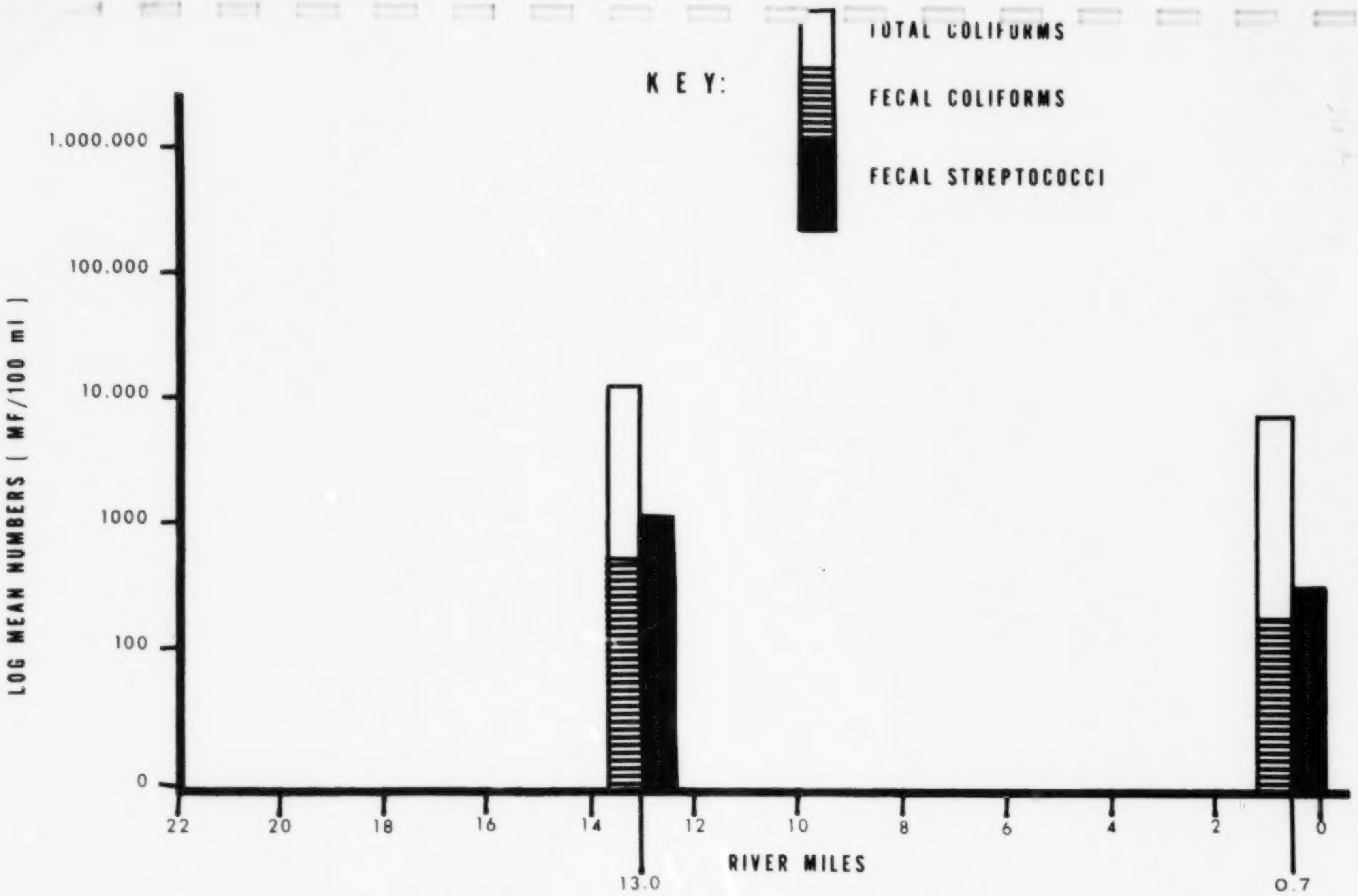
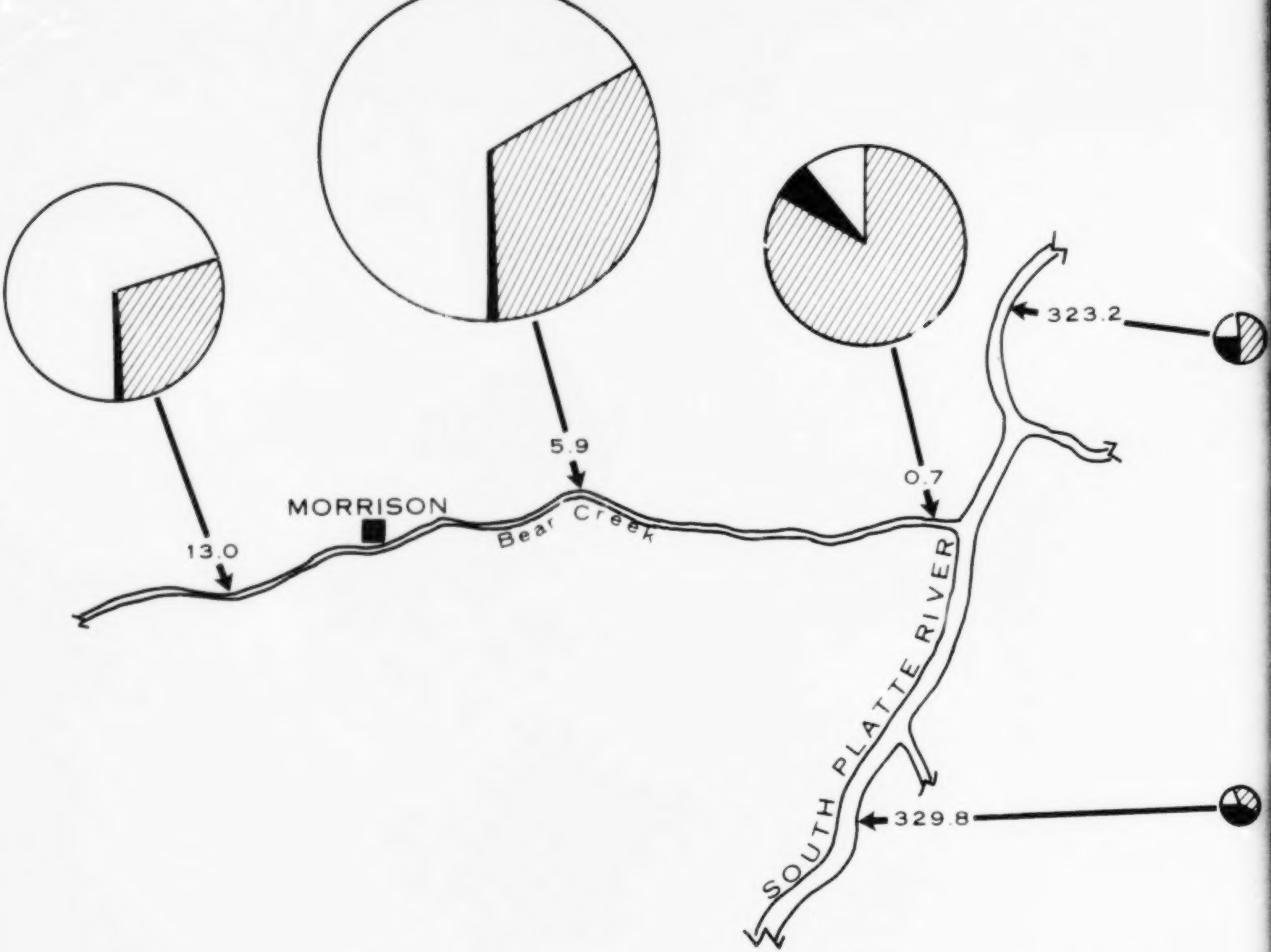


Figure 5 Bacterial Densities, Bear Creek, Colorado
August - September, 1971


MORRISON
Bear Creek
SOUTH PLATTE RIVER
13.0
5.9
0.7
323.2
329.8

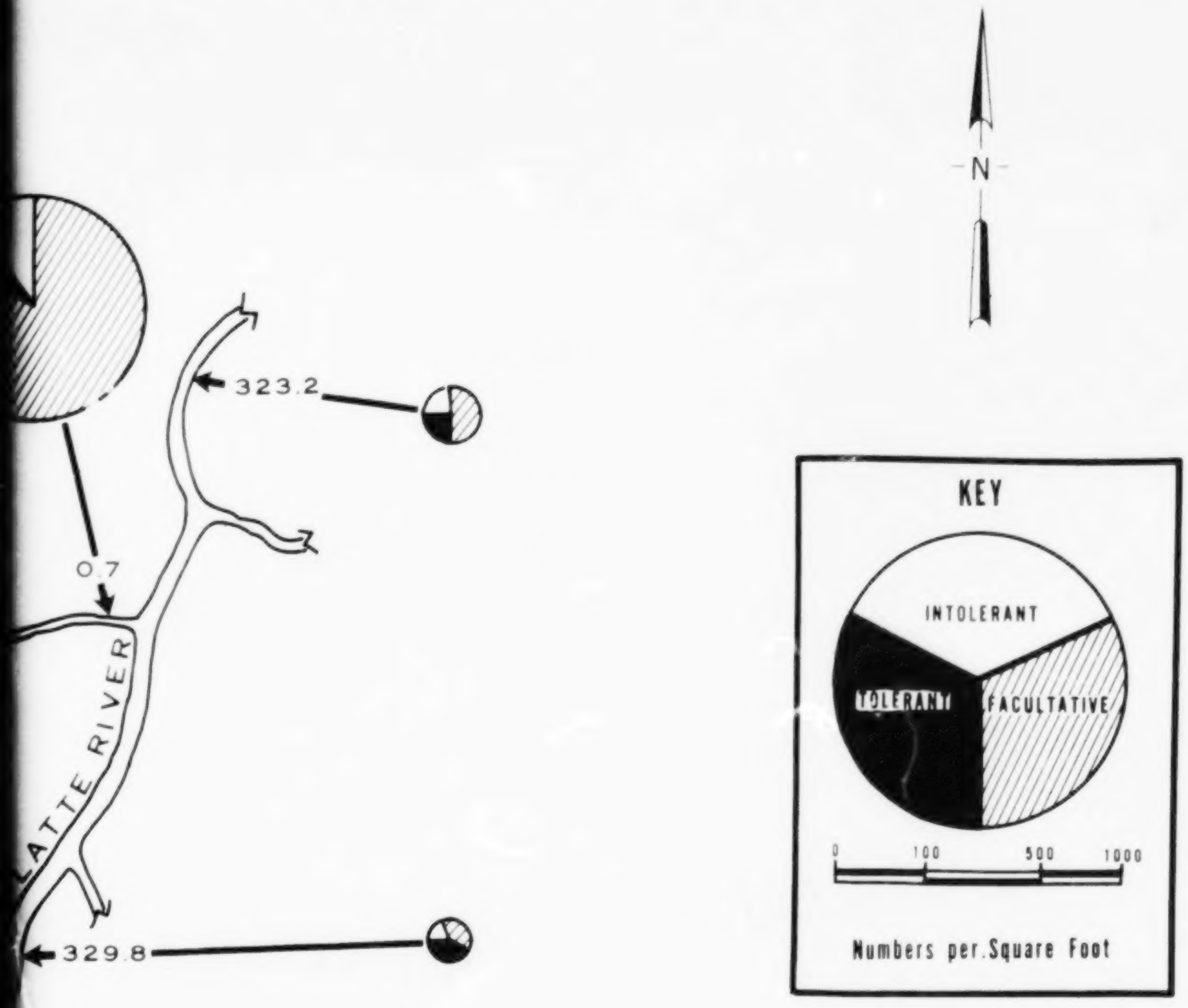
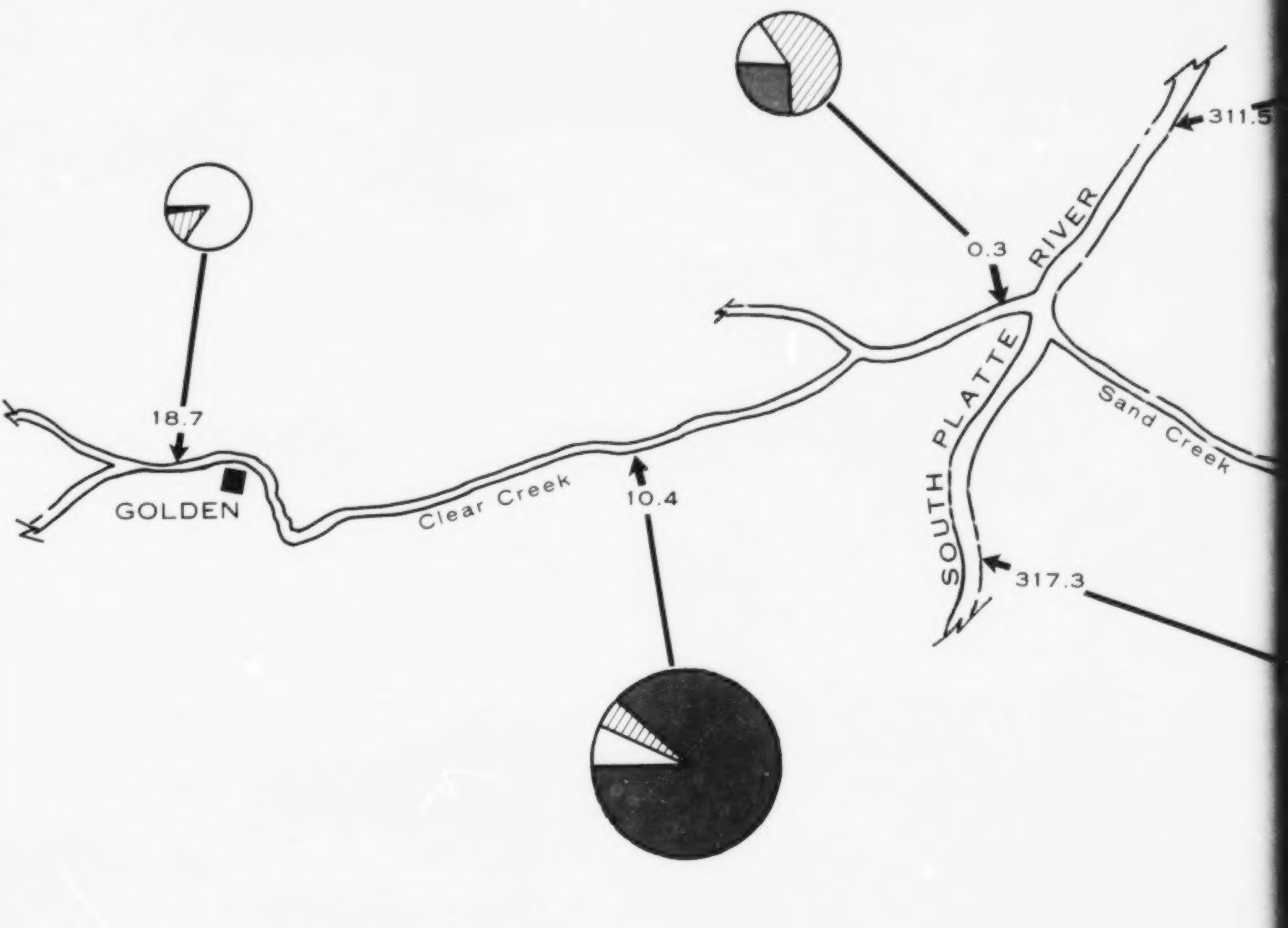


Figure 6. Populations of Benthic Invertebrates, Bear Creek, Colorado September, 1971


18.7
GOLDEN
Clear Creek
10.4
0.3
RIVER
SOUTH PLATTE
Sand Creek
311.5
317.3

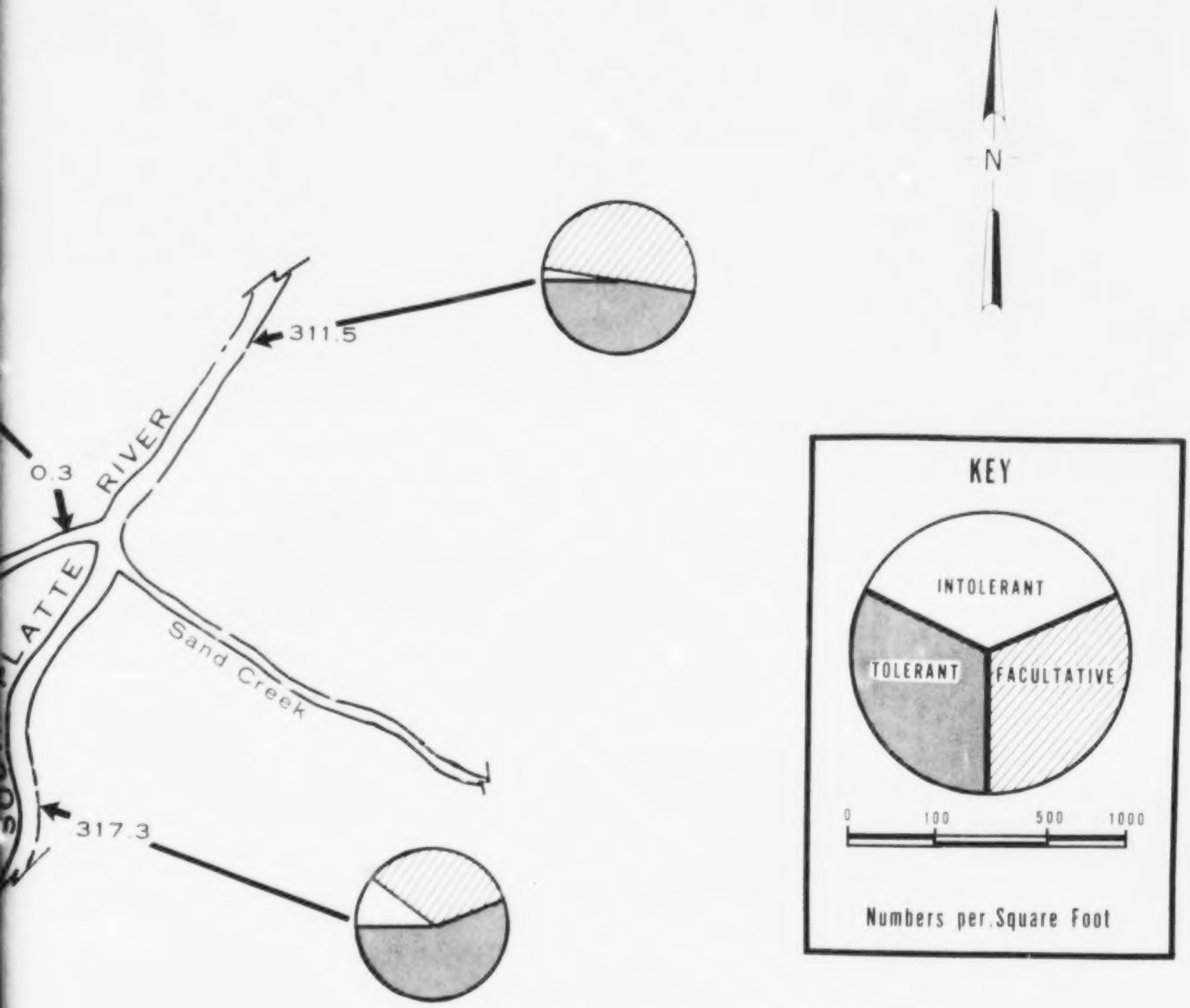


Figure 7. Populations of Benthic Invertebrates
Clear Creek, Colorado, September, 1971

September 21-24, 1971 indicated that the average wastewater discharge of 7.2 mgd contained 6,000 lb of BOD.

It was reported in 1966[4/] that Clear Creek downstream from Golden supplied nine municipal water systems and numerous irrigation ditches. These various diversions account for the extreme low-flow conditions that occur in the summer months. During the summer 1971 stream survey the average flow at the USGS station (RM 18.7) upstream of Golden was 185 cfs. Downstream from Golden the flow was reduced by diversions to 21 cfs at York Street (RM 0.3). At times, flow in the lower reaches of Clear Creek is almost entirely wastewater from sewage treatment plants and the Coors brewery.

At McIntire Road (RM 14.1), downstream from the Coors wastewater treatment plant, the log mean fecal-coliform bacteria density was 5,800/100 ml [Figure 8], a violation of the bacterial standards for a potable water supply [Appendix A]. The DO decreased to 3.4 mg/1, which was a violation of the oxygen criterion (4.0 mg/1).

At Kipling Street (RM 10.4) organic materials had settled on the stream bed, forming sludge beds that were damaging to aquatic biota. The density of benthos increased to 536 organisms/ft^2; 89 percent were pollution-tolerant sludgeworms and snails and only seven percent were intolerant organisms [Figure 7].

Upstream of this station residual wastes from small treatment plants, storm sewers, and urban runoff contributed to the pollution of Clear Creek. Violations of Sections B and D of the Basic Standards Applicable to All Waters of the State occurred. However, quality conditions observed during this survey are in marked contrast to conditions observed during studies by the South Platte River Basin Project[4/] in 1964 which showed, under similar flow conditions, BOD and DO values of 95 and 1.8 mg/1, respectively. Dissolved oxygen levels in 1971 were greater than 5 mg/1.

Effluents from both the Baker and Clear Creek Sanitation Districts, and from the Arvada and Wheatridge wastewater treatment plants enter Clear Creek upstream of RM 0.3. These four plants discharge about 6.5 mgd of wastewater, with a daily BOD load of 3,600 lb, to the creek.

Near the mouth of Clear Creek (RM 0.3) the DO levels were similar to those observed at RM 10.4. Fecal-coliform bacteria densities of 780/100 ml did not exceed the standards. Benthic organisms decreased to $127/ft^2$, but the variety increased to 14 kinds and pollution-intolerant organisms made up 17 percent of the total. Most of the increase in the variety was due to the presence of additional facultative forms. All of the fish collected near the mouth of Clear Creek were non-game species.

In summary, there has been an improvement since 1964 in the water quality of Clear Creek, from RM 10.4 continuing downstream. However, violations of the standards for bacteria, dissolved oxygen, and sections B and D of the Basic Standards were observed.

C. BOULDER CREEK

At RM 27.6, upstream of the city of Boulder, Boulder Creek had good water quality [Table D-2, BOD 0.8-1.0], was free from serious bacterial contamination [Figure 9 and Table E-2], and supported a good biotic community. Algal growth provided food and a habitat for 17 kinds of aquatic insects and crustaceans. The fish population in this reach included trout, suckers, and minnows.

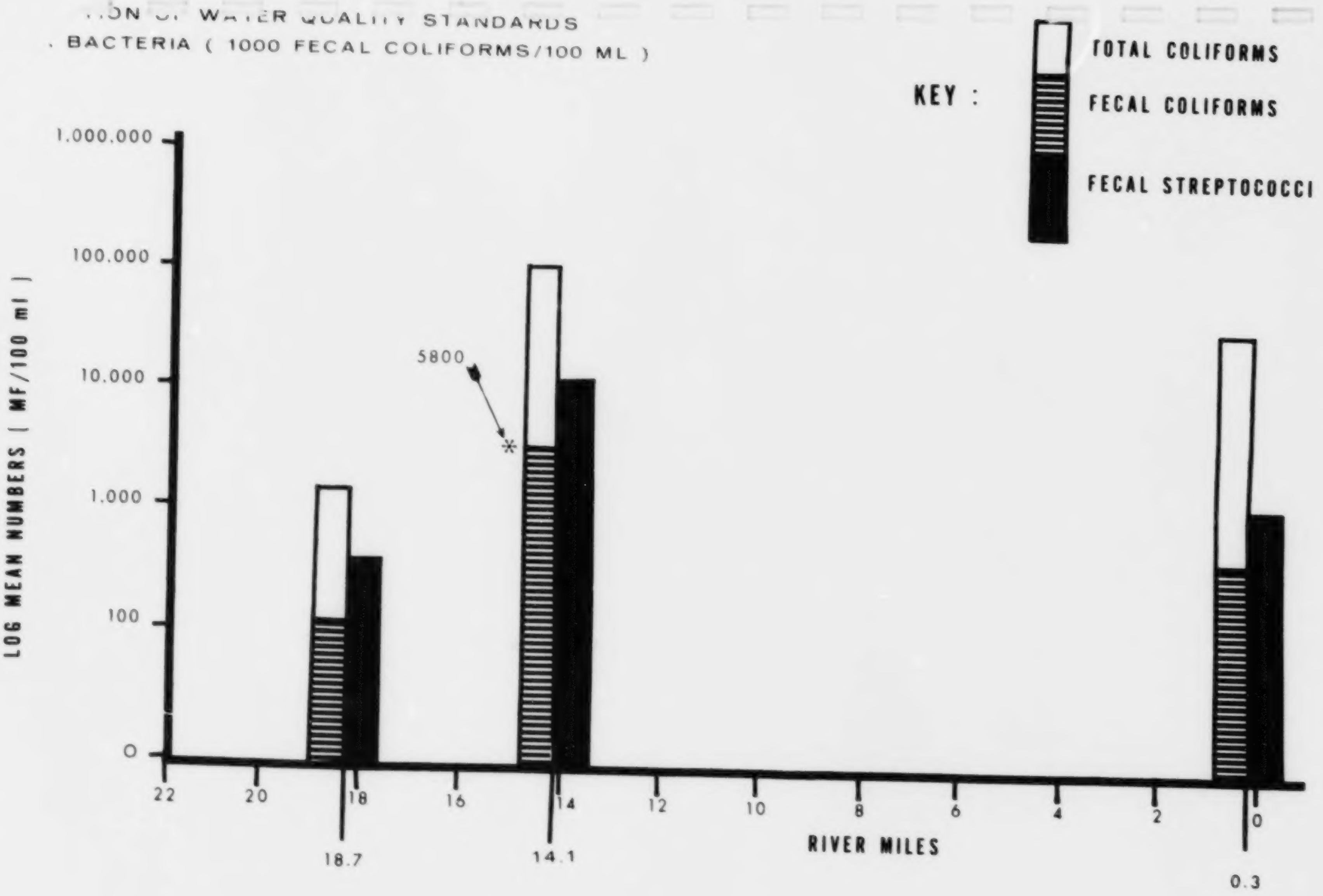


Figure 8 Bacterial Densities, Clear Creek, Colorado
August - September, 1971

·TION OF WATER QUALITY STANDARDS
· BACTERIA (1000 FECAL COLIFORMS/100ml)

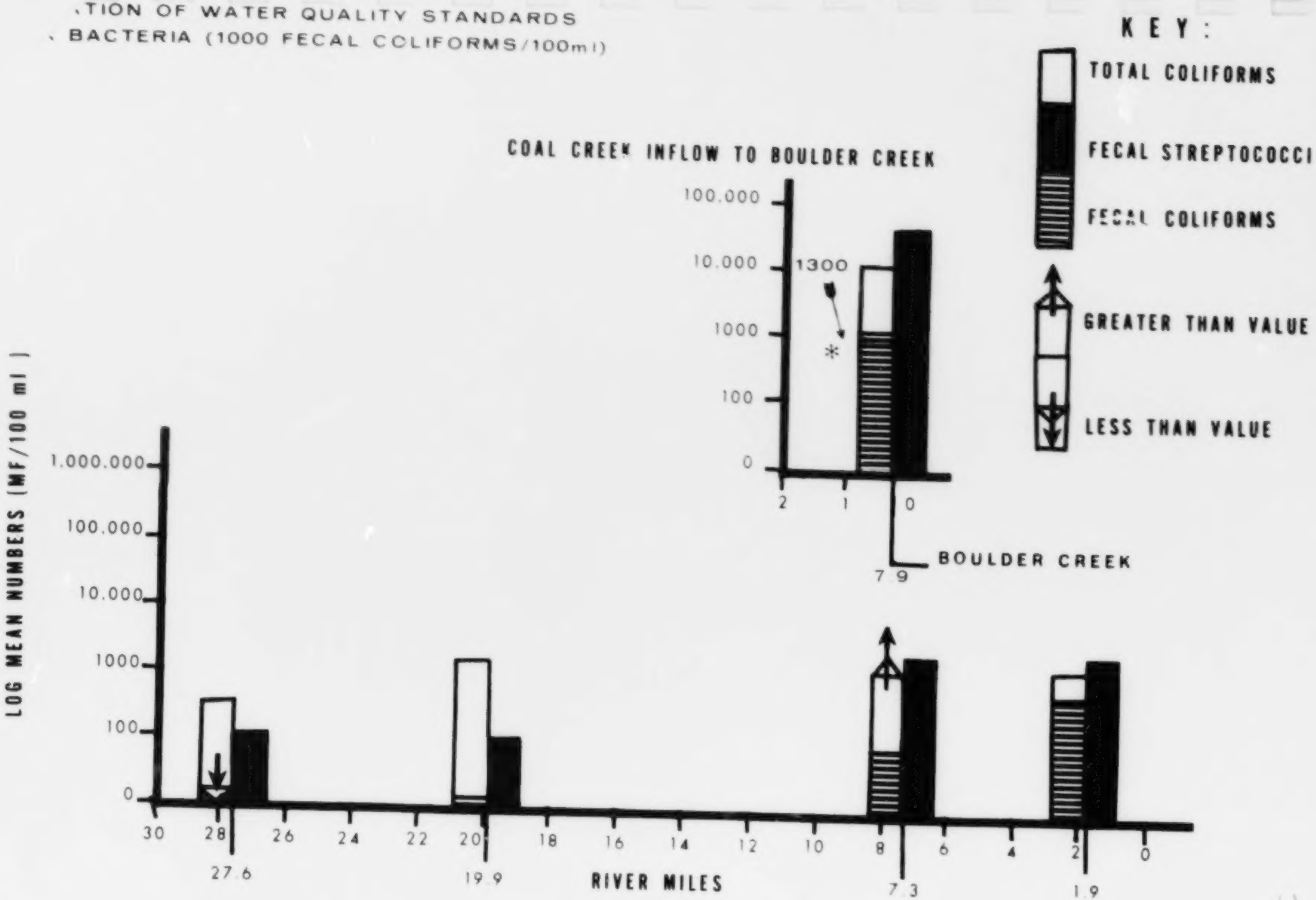


Figure 9 Bacterial Densities, Boulder Creek, Colorado
September, 1971

Boulder has two municipal wastewater treatment plants that discharge to the creek. The outfail of the Pearl Street plant is located at RM 21.3 and the 75th Street plant discharges at RM 17.8. During an evaluation of these plants in August 1971 an average BOD of 4,400 lb per day was being discharged.

Downstream from the Pearl Street plant outfall, at RM 19.9, the bacteriological quality [Table E-2] of Boulder Creek remained acceptable, thus indicating adequate disinfection of the city sewage. The BOD was 14 mg/1. The stream in this reach was murky and smelled of sewage. The stream bed was blanketed with sludge and supported a bottom community indicative of organic pollution [Figure 10 and Table G-3]. These conditions were in violation of Sections B and D of the Water Quality Standards.

Streamflows at RM 27.6 averaged 56 cfs while near the mouth (RM 1.9) they averaged 7 cfs because of numerous irrigation diversions. Flows were affected between these two points by tributary and waste inflows, and upstream of the irrigation diversions it is estimated the flow reached 100 cfs.

In the lower reach the effects of Coal Creek (RM 7.3) were evident. Coal Creek receives municipal wastewater effluents from the communities of Erie, Lafayette, and Louisville. Degradation from these sources was shown by poor bacterial and chemical water quality in Coal Creek (FC=1,300/100 ml, FS=72,000/100 ml and BOD=13 mg/1).

Boulder Creek water quality and substrate were sufficiently improved at RM 1.9 to support a diverse bottom community (19 kinds, including mayflies and caddisflies) and a fish population of smallmouth bass and various non-game fish.

In summary, the severe effects of organic pollution reported in 1967[7] as originating from the municipal plant at Boulder were less evident in this study. Water quality and the stream bed environment of Boulder Creek were degraded by Boulder municipal wastewater effluents, but conditions successively improved downstream to Coal Creek. Inflow from Coal Creek chemically and bacteriologically degraded lower Boulder Creek.

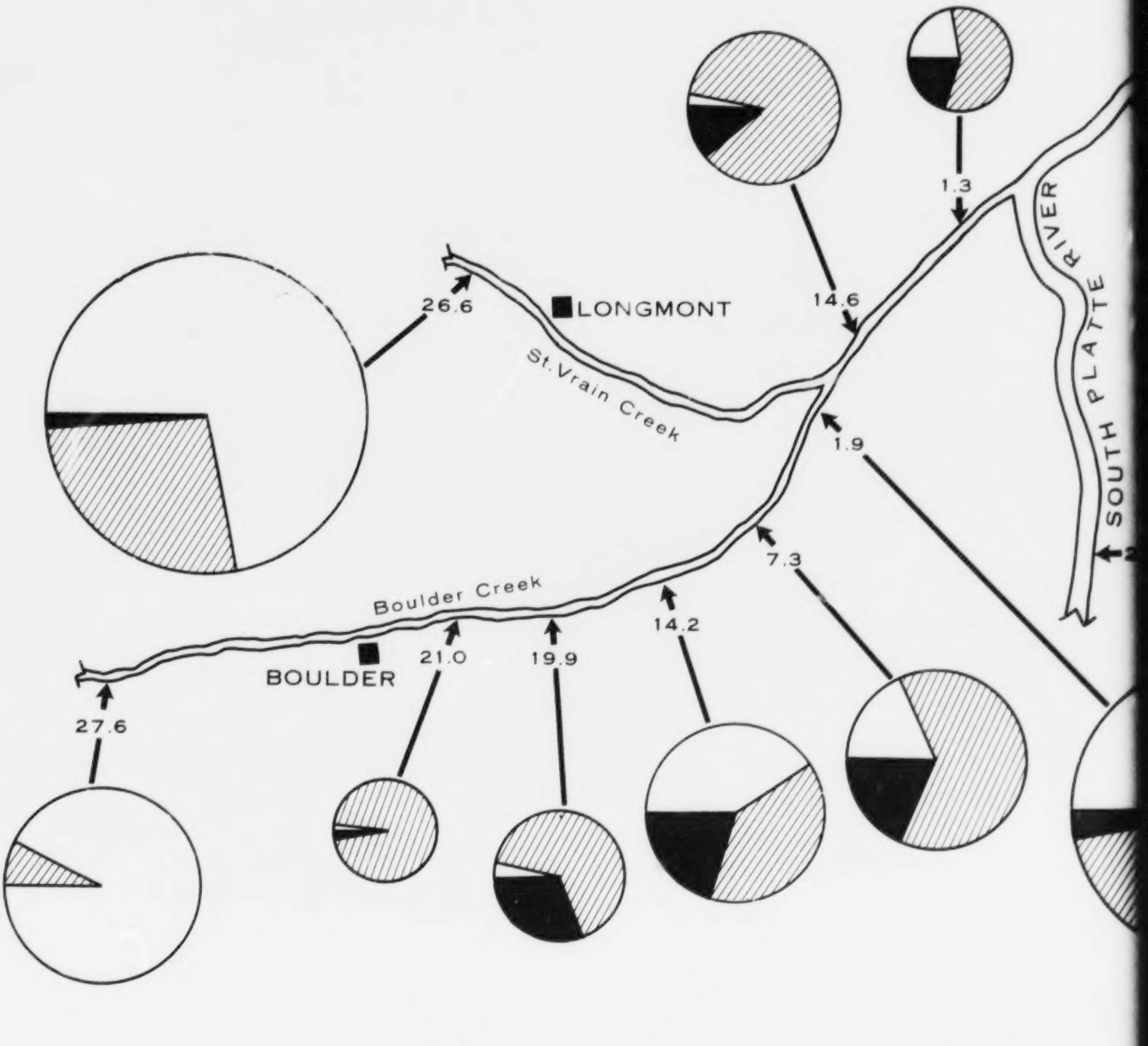
D. ST. VRAIN CREEK

Summer Survey - (September 7-10, 1971)

The flow of St. Vrain Creek was affected by diversions and by inflows from tributaries and waste sources. The flow rate was estimated at 25-30 cfs upstream of Longmont (RM 26.6) and averaged 211 cfs at a gaging station (RM 1.3) near the mouth.

Upstream of Longmont the creek was shallow and swift, with good water quality [Table D-2] and with a sand and rock-rubble bottom. Attached algae provided aquatic animals with food and shelter. Game fish, including trout and largemouth bass, were collected in St. Vrain Creek upstream of Longmont. Other fish found inhabiting this area were carp, suckers, chubs, dace, and minnows. A variety (29 kinds) of invertebrates were found inhabiting the stream bed, especially in the algae. Among the invertebrates found were immature mayflies, caddisflies, and stoneflies [Table G-4]. The presence of these insects in diverse communities reflected an unpolluted aquatic environment.

Wastewater (approximately 4.0 mgd) from the Longmont treatment plant


26.6
LONGMONT
St. Vrain Creek
14.6
1.3
SOUTH PLATTE RIVER
1.9
7.3
Boulder Creek
14.2
19.9
21.0
BOULDER
27.6

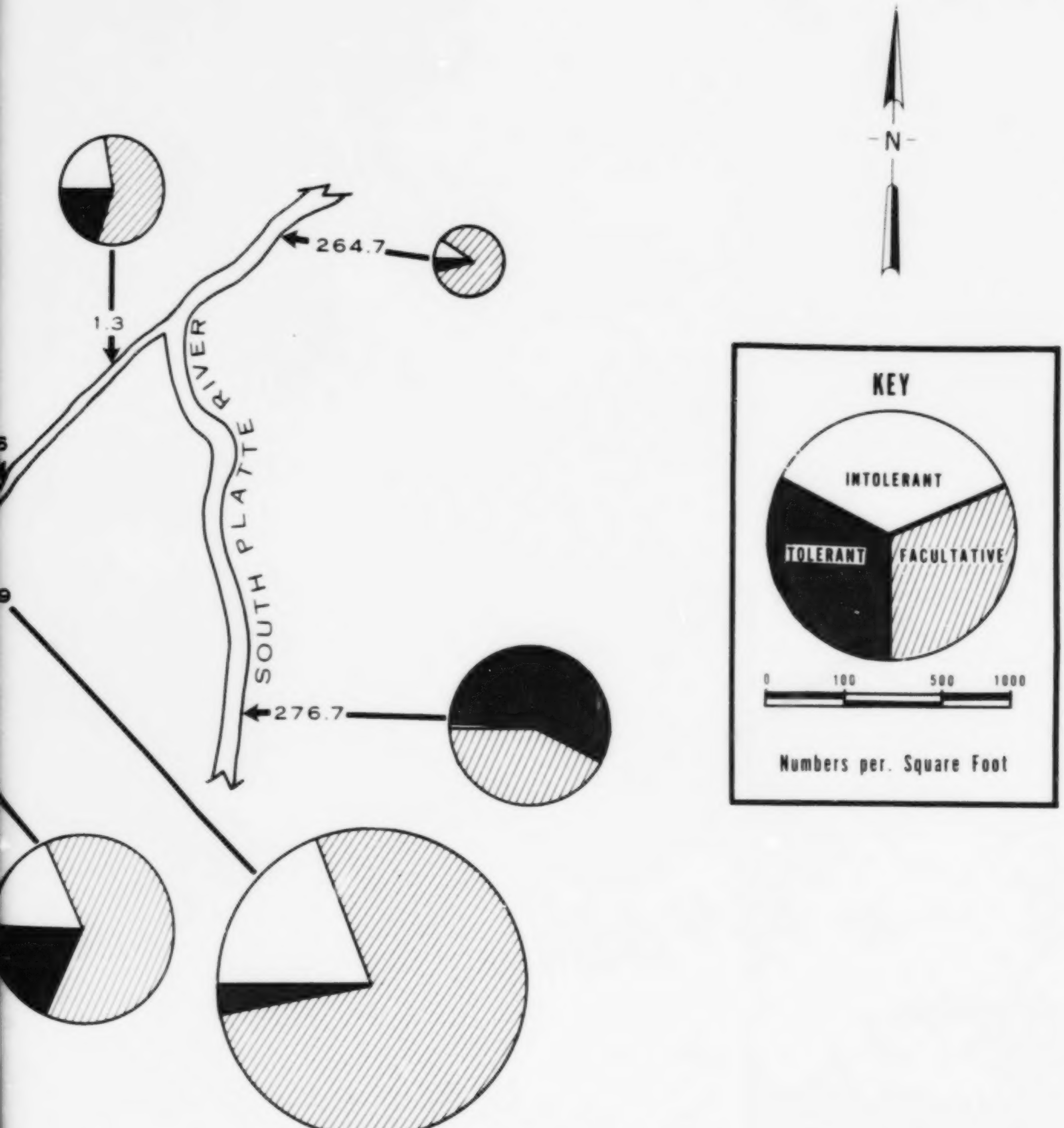


Figure 10. Populations of Benthic Invertebrates
St. Vrain and Boulder Creeks, Colorado.
September, 1971

enters St. Vrain Creek at RM 22.5. At the point of discharge the effluent was essentially the entire flow of St. Vrain Creek because upstream, the creek was diverted to the water supply pond of the Great Western Sugar Company, with excess flow diverted back to St. Vrain Creek at RM 22.0. Evaluations of the Longmont plant showed that it discharged from 1,750 to 2,100 lb of BOD per day. Downstream, at RM 20.8, the effect of the Longmont plant discharge was evident. The fecal coliform densities increased to 1,400/100 ml [Figure 11]. These wastes and wastes from feedlots and other agricultural activities degraded the creek from Longmont downstream to its confluence with the South Platte River [Table D-2]. At RM 14.6 the creek carried large amounts of solids (mean total solids value of 1,020 mg/1), giving the water a murky appearance. In slack areas of this stream reach the heavier solids settled to the creek bed, forming sludge deposits. Effects of the suspended solids and putrifying bottom sludge were reflected by changes in the creek bottom animal community [Figure 10]. Pollution-sensitive forms, found in abundance upstream (RM 26.6), were reduced in number or eliminated by pollution at RM 14.6. Violations of section B and D of the Basic Water Quality Standards, applicable to all Colorado waters, occurred.

Water quality improved near the St. Vrain Creek mouth at RM 1.3. Although the water was still murky (mean total solids value ranged from 630-920 mg/1), sludge deposits were less evident and fecal bacteria were reduced, as compared to upstream at RM 20.8 [Table E-2]. Benthic organisms reflected the improved stream-bed condition by an increase in their variety, including a few pollution-sensitive invertebrates, e.g. stoneflies, caddisflies, and mayflies [Figure 10]. Stream conditions remained unsuitable for a game-fish population. The fish community was composed of carp, shad, and various minnows.

Comparison of the 1964 and 1971 surveys revealed a trend toward improved environmental conditions downstream from Longmont. The closure of a Longmont cannery contributed to this improvement. The Kuner-Empson cannery had polluted St. Vrain Creek in previous years by discharging wastewater containing solid pieces of vegetables. The resultant waste was reported scattered over the creek bottom and along its banks for several miles downstream from the cannery discharge.[7] These conditions were not observed during the 1971 survey.

Other evidence of improvement since 1964 included: better water quality; reduction in algal mass; less bacterial contamination; and an increase in the diversity of bottom organisms, especially near the creek mouth.

Fall Survey (December 6-10, 1971)

Upstream of the Great Western Sugar Company mill and the municipal waste treatment plant at Longmont (RM 22.5), St. Vrain Creek had good water quality [Table D-3]. The log mean number of fecal coliform bacteria was 190/100 ml of water [Table E-4]. The sandy stream bed provided a relatively poor habitat for benthos as compared to the rubble area (RM 26.6) sampled in September; nevertheless, the benthos collected in December included organisms considered intolerant to organic pollution, such as caddisflies and mayflies. Conditions were indicative of clean water.

As in September, the entire flow of the St. Vrain Creek near RM 22.5 was diverted to the water supply pond at the Great Western mill. The

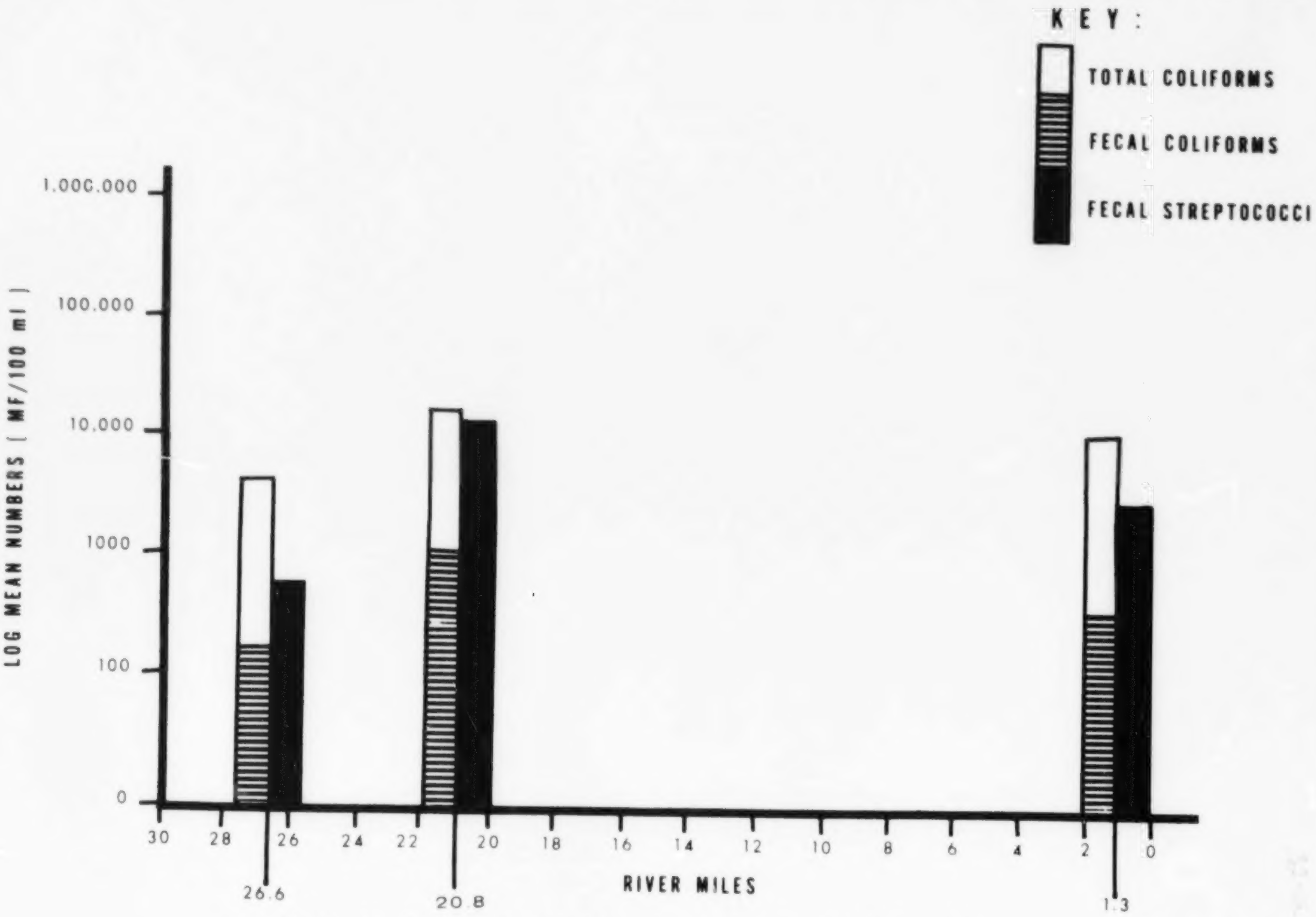


Figure 11 Bacterial Densities, St. Vrain Creek, Colorado
September, 1971

pond overflow joins the mill condenser water, and is discharged to the creek at RM 22.0. A few feet downstream from the water supply is the Longmont municipal waste treatment plant outfall. As was the case in September, this effluent constituted the flow of the St. Vrain Creek from RM 22.5 to 22.0.

Approximately 5,000 lb of BOD per day were discharged into the stream from these two waste sources. The effects of the discharges from the mill and the Longmont treatment plant were evident downstream (RM 20.6). The BOD values ranged from 45 to 65 mg/l and the DO values ranged from 0.3 to 3.7 mg/l, indicating that violations of the DO criteria (3.0 mg/l) were occurring. At this same location the fecal coliform densities increased to greater than 1,300/100 ml as a result of the discharge from the Longmont waste treatment plant. Other types of bacteria were sustained by the nutrients contained in sugar beet wastewaters; *Sphaerotilus*, a filamentous bacterium, covered much of the stream bottom with dense growths (about 4 million filaments/in^2). Organic solids, partly composed of putrifying slimes, formed large sludge beds in this reach of the creek. The intensity of the pollution was sufficient to eliminate virtually all intolerant benthos, such as mayflies and caddisflies, and to greatly reduce the numbers of tolerant sludgeworms and bloodworms [Table G-5].

E. LITTLE THOMPSON RIVER

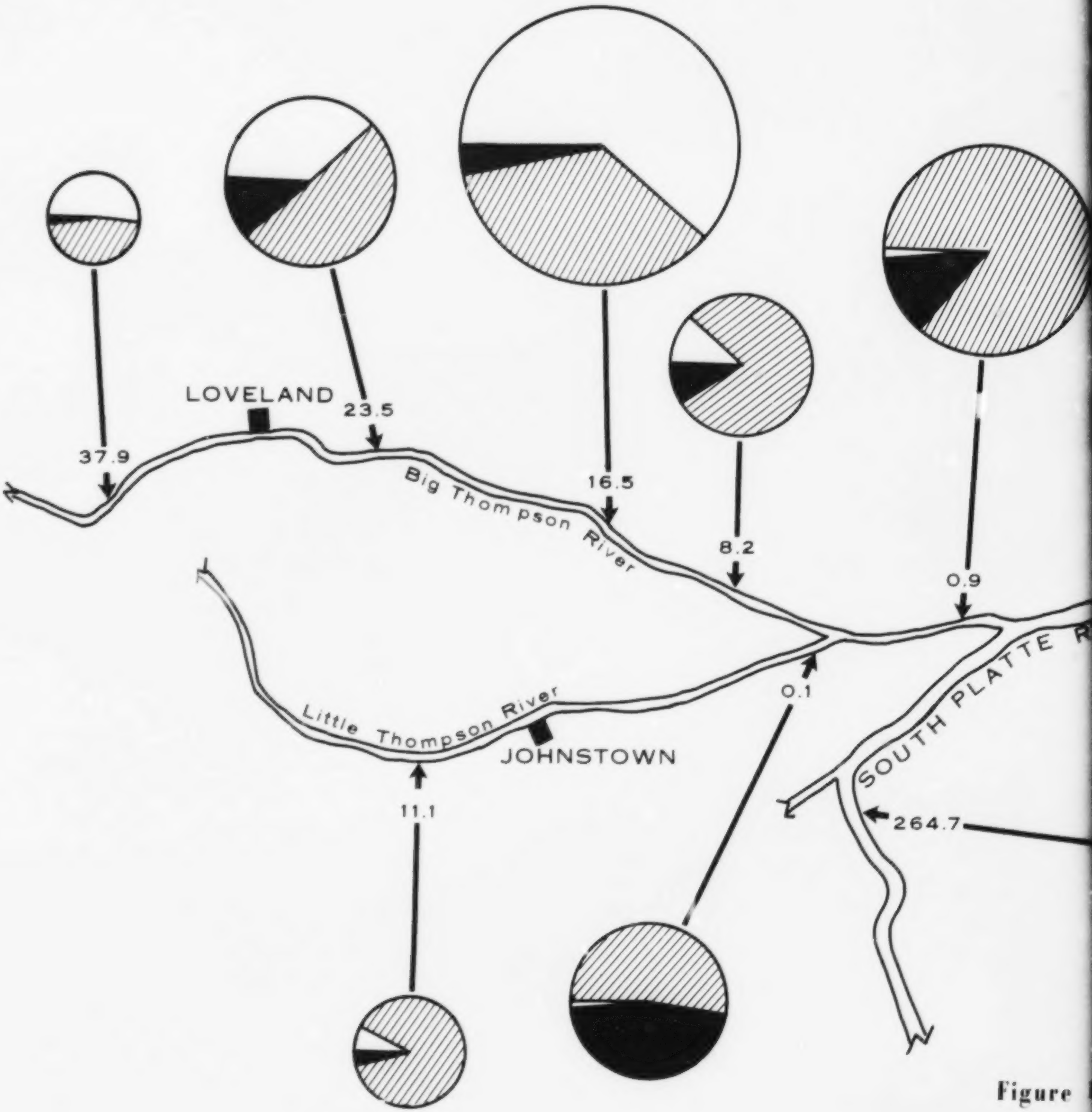
Summer Survey (September 7-10, 1971)

The Little Thompson River was surveyed from near Berthoud (RM 18.9) downstream to its mouth. The BOD at the upstream station was 3.6 mg/l, with the DO varying from 6.0 to 8.1 mg/l. Downstream, at RM 11.1, the river was moderately polluted. Possible sources included: animal feedlot drainage, irrigation return water, unrestricted livestock watering in the stream, and wastes from the Berthoud wastewater treatment plant. Stream damage was indicated by the sparse population of pollution-sensitive invertebrates (seven percent) collected from the stream bed at RM 11.1 [Figure 12].

Downstream at RM 0.1 pollution was more severe than at RM 11.1. Conditions at this station were affected by municipal waste discharges both from Johnstown (RM 1.15; BOD of the effluent ranged from 20 to 40 mg/l)* and Milliken (RM 0.6; effluent BOD averaged about 20 mg/l)* and the discharge (RM 2.8) from the Great Western Sugar Company monosodium glutamate production factory at Johnstown. During the survey the facilities (production operation and sugar recovery plant) were closed for maintenance, but the residual effects of previous discharges were evident. Treated wastewater from this Great Western plant is discharged to the Little Thompson River. A study in 1970 reported "the discharge to the Little Thompson was septic -- and contributed a gray color and hydrogen sulfide odor to the river."[8/] The sustained bacterial contamination [Figure 13] and alterations to the river biota, at RM 0.1, were caused by upstream pollution. The most conspicuous biotic change was the vast development of slime growths. These slimes covered rocks and much of the stream bottom, virtually eliminating the habitable area for many desirable fish-food organisms [Table F-5]. In the Little Thompson River the river-bottom-dwelling animal populations [Figure 12] revealed

---

* These values are based on information obtained from officials of the Colorado State Health Department.


LOVELAND
37.9
23.5
16.5
8.2
0.9
Big Thompson River
Little Thompson River
JOHNSTOWN
11.1
0.1
SOUTH PLATTE R
264.7

Figure

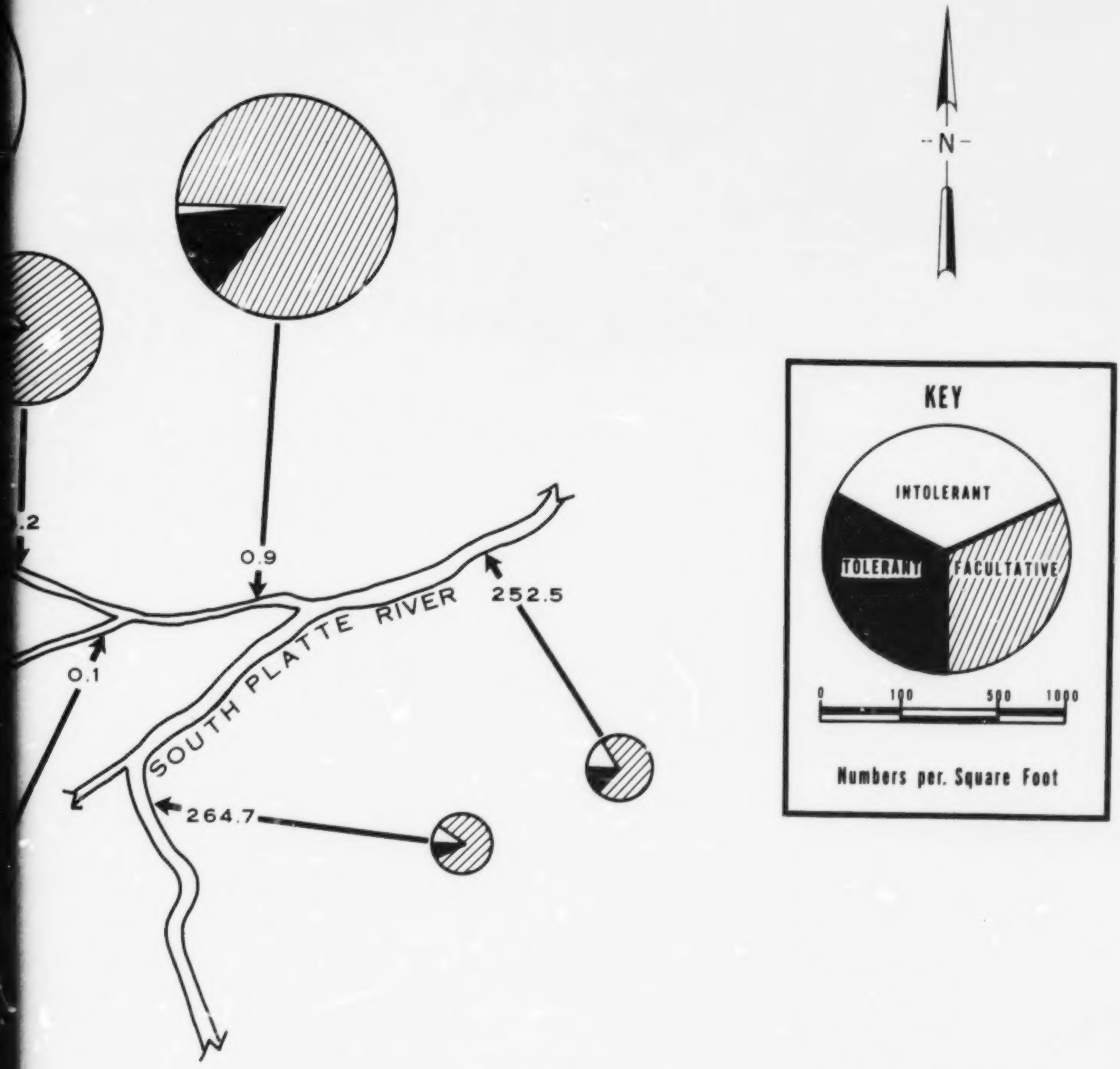


Figure 12. Populations of Benthic Invertebrates, Big Thompson and Little Thompson Rivers, Colorado September, 1971

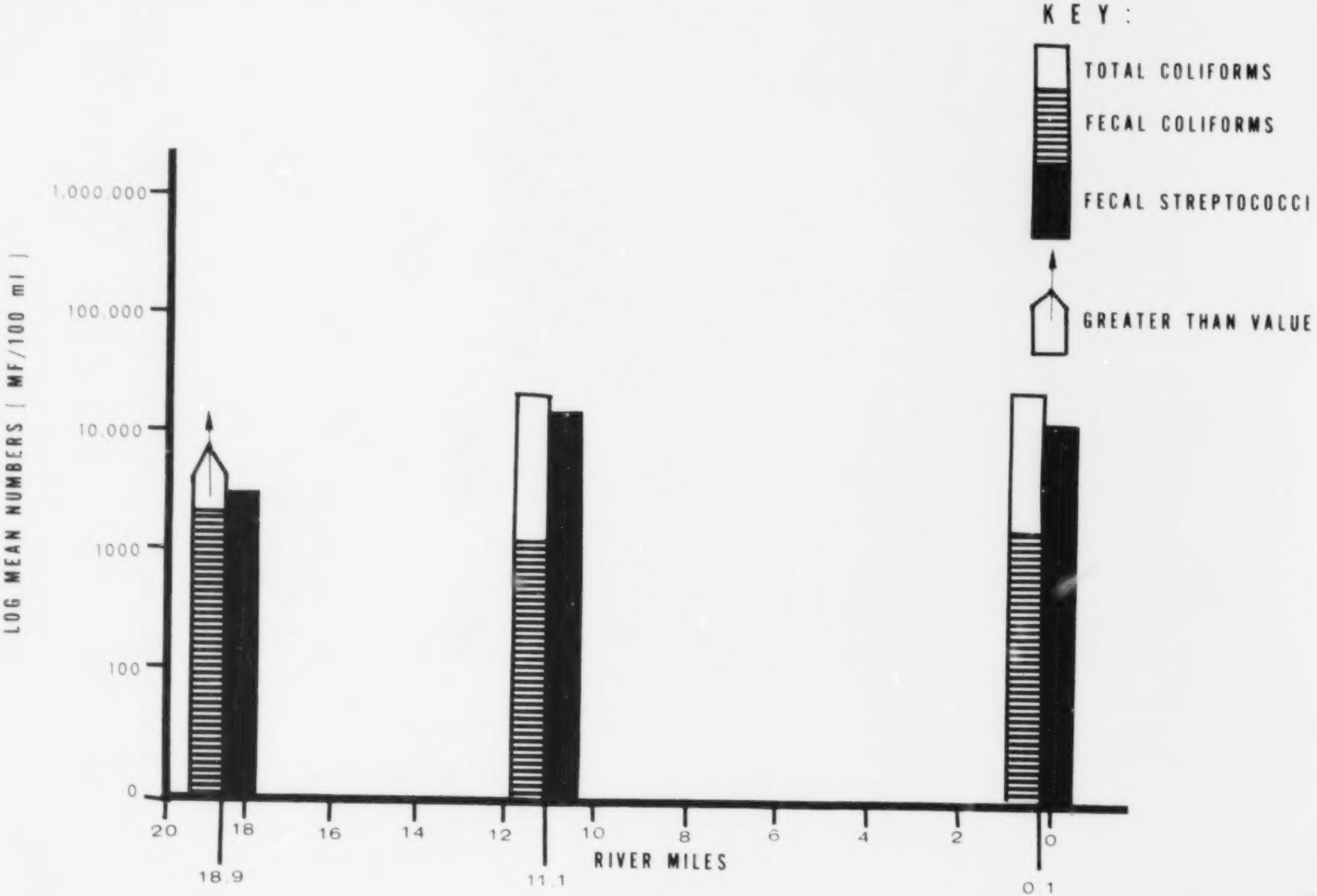


Figure 13 Bacterial Densities, Little Thompson River, Colorado
September, 1971

the adverse effects of pollution including the increase in its severity downstream from the Great Western plant at Johnstown (RM 0.1).

Comparison of the 1971 findings with earlier reported data (1964 and 1966) does not reveal any substantial change in the water quality of the Little Thompson River. Violations, of Sections B and D of the Basic Standards, occurred.

Fall Survey (December 6-10, 1971)

The Great Western Sugar Company at Johnstown was in operation at the time of survey. Upstream from the plant, at RM 4.0, the Little Thompson River was turbid because of sediments transported by the stream. Log mean fecal coliform densities were 360/100 ml and the DO value remained near saturation, with a range of 10.4 to 10.7 mg/l [Table D-5], indicating relatively clean water. The stream bed of shifting sand, at RM 4.0, provided a limited habitat for benthos; a low diversity of eight kinds, with a population of 12 organisms/ft^2 was found. Benthos intolerant of organic pollution (e.g., stoneflies) were among the invertebrates collected.

Downstream (at RM 1.15) from the Great Western complex the Little Thompson River was severely polluted. Both the BOD and the fecal coliform bacteria increased by a factor of 20 and the DO was reduced from 10.4 mg/l to 4.0 mg/l. Dense slime growths, including *Sphaerotilus*, covered rocks and logs submerged in the stream. Some of the filamentous bacteria were observed floating downstream in the river currents. Near the shoreline and in other slack areas these filaments settled to the stream bed, contributing to the formation of sludge banks. The bottom animal community was affected and was limited to a few mollusks, fly larvae, beetles, and sludgeworms [Table G-7].

Sections B and D of the Basic Standards were being violated. Moreover, conditions in the Little Thompson River have not improved since 1965 when studies by the Project[4/] showed high BOD (22-114 mg/l) and fecal-coliform bacteria densities exceeding 10,000/100 ml downstream from Johnstown.

F. BIG THOMPSON RIVER

Stream flow in the study reach fluctuated because of irrigation diversions and return flows. Previous studies[9/] indicated that the flows in certain reaches are practically depleted during the irrigation season.

Summer Survey (September 7-10, 1971)

At RM 37.9, upstream of Loveland, the Big Thompson River was small, shallow, swiftly flowing, and had numerous gravelly riffles. Bacteriological and chemical analyses of the water indicated that the area was free from major organic waste sources [Table D-4]. However, nutrients were sufficient to stimulate growth of attached algae covering large boulders submerged in the stream. Diverse invertebrate fauna (22 kinds), including numerous pollution-sensitive mayfly and stonefly nymphs, were found among the algae and on the stream bed. These organisms are basic food items for trout and other fish that inhabited this area.

The Loveland Packing Company (RM 25.6) and the Loveland municipal wastewater treatment plant (RM 24.5) discharge into the Big Thompson River. Subsequent investigations of these two waste sources indicated that the packing plant discharges about 80 lb BOD/day and the treatment plant about 1,400 lb/day. Downstream from Loveland (RM 23.5) effects of these waste loads were evident. The water was murky (average SS 570 mg/l), smelled of sewage (fecal coliform 1,300/100 ml) [Figure 14] and contained excessive amounts of nutrients (average values 0.7 mg/l total P and 0.90 mg/l NO_2-NO_3-N). Chemical and physical changes in the stream-bed environment adversely affected the biota. Some sensitive invertebrate organisms, such as immature stoneflies, were found in unpolluted upstream habitats (RM 37.9), but were not present in bottom samples taken at RM 23.5. There was a proportional decrease in sensitive organisms and an increase in tolerant animals, such as sludgeworms, with an overall increase in the total number of organisms/ft^2 [Figure 12]. Coupled with an increase in BOD, TOC, and solids [Table D-4], these changes reflected organic pollution.

Further downstream, at RM 16.5, the water became clear, but plant nutrients remained in high concentrations (average values for total P of 0.5 mg/l and NO_2-NO_3-N of 1.2 mg/l). These conditions provided an ideal environment for a development of periphyton growth. The stream bed and algae provided a satisfactory habitat for a variety of invertebrates (18 kinds) including numerous pollution-sensitive mayfly nymphs (830/ft^2) and caddisfly larvae (34/ft^2).

At RM 8.2 the river transported silt (SS as high as 60 mg/l) that originated from upstream, irrigation-return water. The turbid water contained a sparse amount of algae and, in low-velocity areas, the silt settled over the original sand and gravel bottom. The bottom animal response to these changes, e.g., a reduction in both variety (four less kinds) and number of organisms (1,019/ft^2 less) is illustrated in Figure 12.

The polluted waters of Little Thompson River enter at RM 7.0. This tributary transported suspended solids [Table D-4], some in the form of drifting slimes, and high densities of fecal-coliform bacteria [Figure 11 and Table E-2] into the Big Thompson River. Downstream at RM 0.9 the Big Thompson River was extremely turbid and had a SS value of 140 mg/l. Fecal-coliform bacteria densities were 2,600/100 ml in this reach. Sludge deposits were conspicuous; these were principally composed of slime filaments that had settled to the bottom and destroyed the benthic habitat. Sludgeworms and fly larvae tolerated the bottom conditions and accounted for 99 percent of the animals that were recorded. The fish population reflected the adverse effects of pollution. Game-fish were absent, and suckers dominated the population, e.g. 137 of 141 fish captured were white suckers. Comparison between the 1971 and 1964 studies did not show any marked improvement in the environmental conditions of the Big Thompson River. Sections B and D of the Basic Standards were violated.

Fall Survey (December 6-10, 1971)

Upstream of the Great Western Sugar Company waste source at Loveland (RM 25.6) the quality of the Big Thompson River was good. Except for expected seasonal changes, the biological conditions were similar to those recorded for the area upstream of Loveland during the summer survey (RM 37.9) [Tables G-8 and G-9]. The diverse invertebrate community (22 kinds) included stoneflies, mayflies, and several other kinds of pollution-sensitive organisms.

Water from the Loveland municipal waste treatment plant enters the Big Thompson River at RM 23.5. Downstream from this point effects of

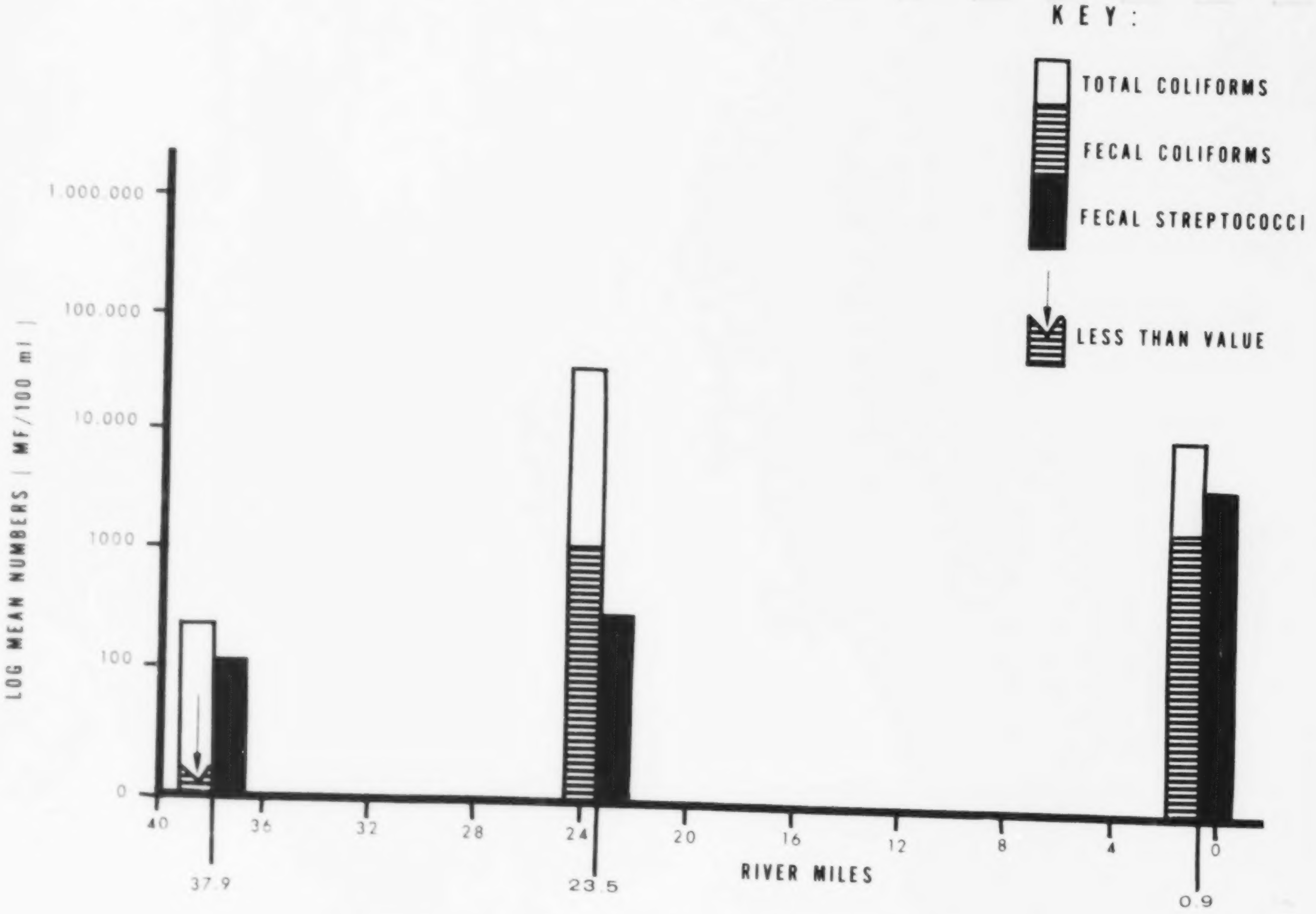


Figure 11 Bacterial Densities, Big Thompson River, Colorado
September, 1971

the waste discharge were evident, as was the case during September. The dominance of sludgeworms (63 percent) in the bottom-dwelling animal community and the excessive algal growths (7.4 million cells/in^2) were biotic responses to organic wastes.

The Great Western mill at Loveland (RM 22.0) discharged (one outfall) an average of 800 lb BOD/day from the lagoons. An unknown amount of seepage from the lagoons was also entering the Big Thompson River. Water quality downstream (RM 21.0) from the Great Western discharge was similar to that observed at RM 23.5.

Comparison of the December data with the study results of January 1964[10/] indicated that there has been a substantial improvement in the quality of effluent discharged by the sugar mill. The effluent BOD in 1964 averaged 510 mg/l, whereas the recent survey showed an average of 13 mg/l.

G. CACHE LA POUDRE RIVER

Numerous diversions caused flow in the Cache la Poudre River to vary from station to station in September 1971. For example, the river flowed at 218 cfs as it came out of the canyon (RM 55.5). A flow of 311 cfs from a storage reservoir increased total flow to more than 500 cfs. However, this flow was reduced to about 45 cfs along its course through Fort Collins. Fluctuations continued downstream as water was added through seepage, irrigation returns, and tributaries, and was reduced through diversions. Near the mouth of the Cache la Poudre, the flow was 110 cfs.

Summer Survey (September 13-16, 1971)

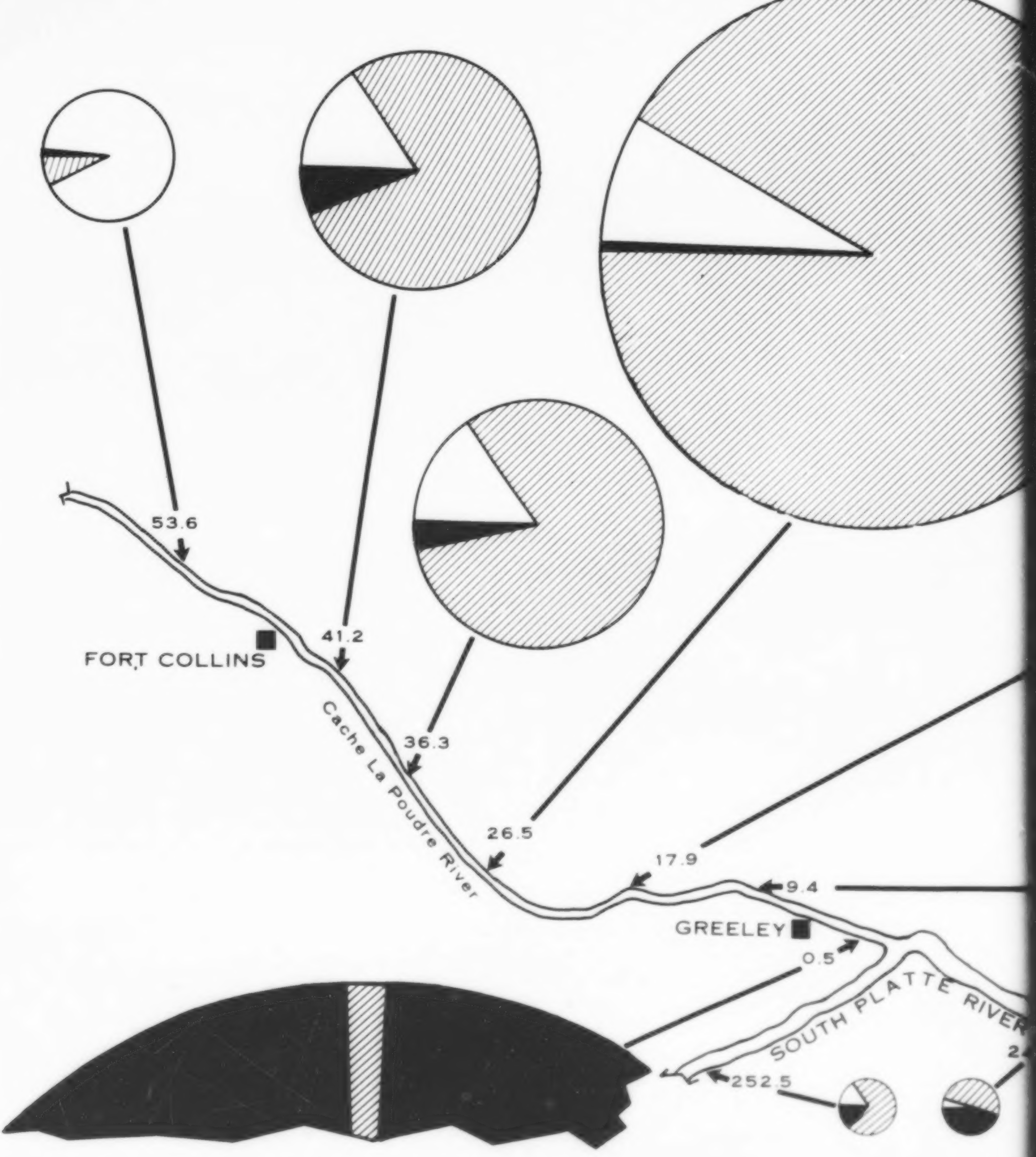
Upstream of Bellvue, at RM 53.6, the river was clear and swift-flowing, with sparse growths of algae. Chemically [Table D-6] and bacteriologically [Table E-2], the water was of good quality. A diverse invertebrate community was found inhabiting the stream bed. Immature stoneflies, mayflies, and other pollution-sensitive invertebrates were a common constituent [Figure 15]. The environment was suitable for existing populations of rainbow and brown trout.

The effluent from the Fort Collins Wastewater Treatment Plant No. 1 entered downstream at RM 44.10. This plant discharged to the stream about 1,900 lb BOD and 3,500 lb of SS/day. At RM 41.2 effects of the waste discharge on the river were evident. Dense mats of algae and pond weeds covered much of the stream bottom. The aquatic growths were sustained by high concentrations of nutrients [Table D-6] originating from the treatment plant. Additional changes in the stream biota were observed at this station. Several pollution-sensitive invertebrates were eliminated while facultative and tolerant invertebrates increased in numbers. This community change is the classical response of bottom-dwelling animals to organic pollution [Figure 15]. The fish population in this area was composed of bullheads, sunfish, suckers, carp, and various minnows.

At RM 40.2 Ft. Collins Wastewater Treatment Plant No. 2 discharged approximately 1,200 lb BOD and 1,000 lb of SS/day into the river.

Stream improvement at RM 36.3 was limited by wastewater contamination from the Fort Collins plant No. 2, and irrigation return water. Signs of improvement included a reduction in the algal growth [Figures 17 and 18], compared to RM 41.2, and a fish population of largemouth bass, pumpkinseed, bullhead, and yellow perch [Figure 19].

Downstream, at RM 26.5, optimum conditions existed for the production


53.6
41.2
FORT COLLINS
Cache La Poudre River
36.3
26.5
17.9
9.4
GREELEY
0.5
SOUTH PLATTE RIVER
252.5
2

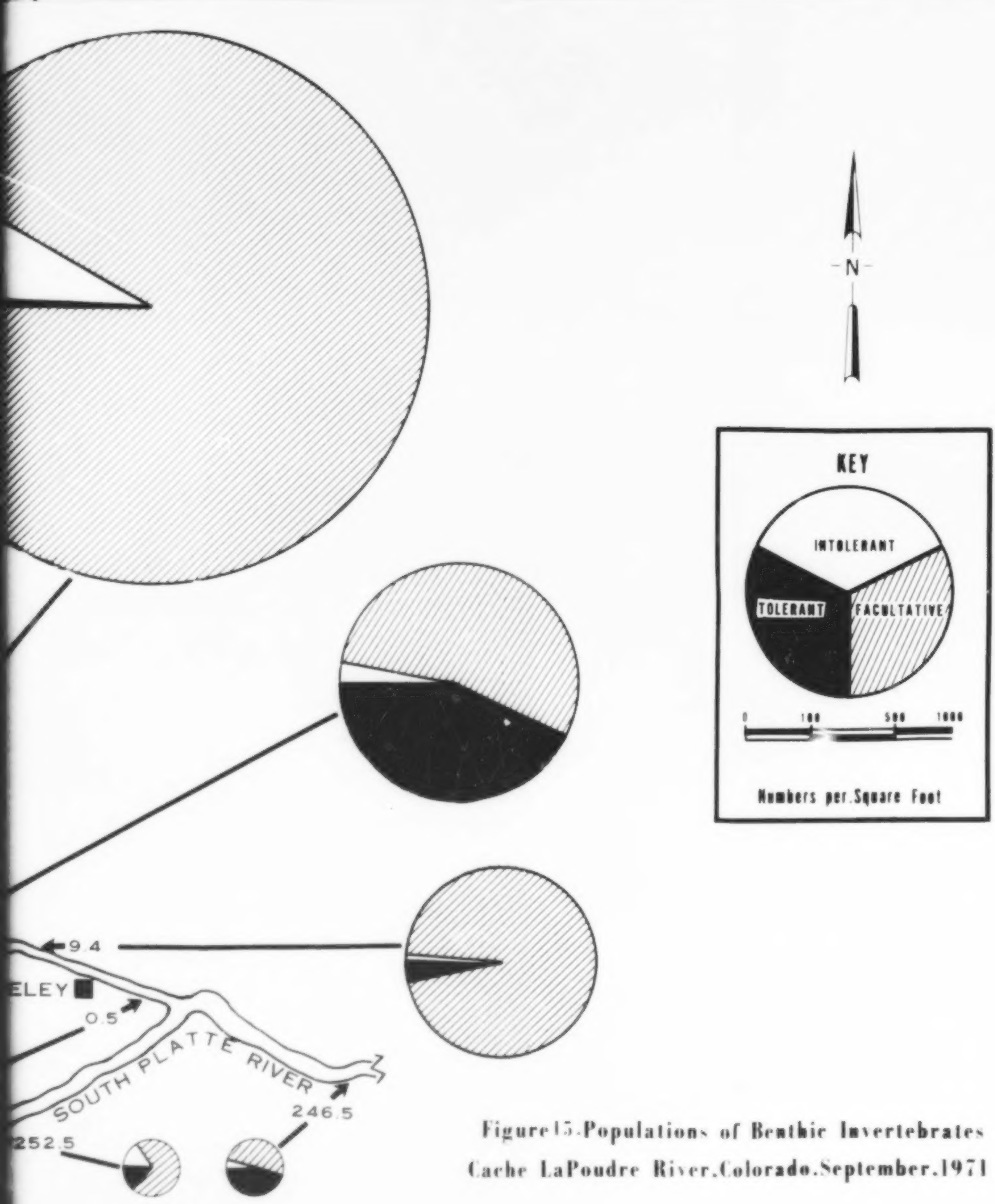


Figure 15. Populations of Benthic Invertebrates
Cache LaPoudre River. Colorado. September. 1971

of black fly larvae. Nearly 6,000 of the 6,724 animals/ft^2 were immature black flies. These larvae feed by filtering bacteria (total coliforms equalled 4,600/100 ml) and microscopic organic matter from the flowing stream. Upon emergence the terrestrial adults are a blood-feeding nuisance and disease-vector to man and livestock. The BOD at this station was 3.9 mg/l and DO levels were above saturation.

Stream enrichment stimulated algal growth at RM 17.9. Prevalence of facultative and pollution-tolerant bottom animals [Figure 15] and a tolerant fish population, primarily composed of minnows and suckers, reflected the adverse effects of organic enrichment in this river stretch.

At RM 9.4 the BOD was 1.9 mg/l and the log mean fecal coliform density was 640/100 ml, which is within the bacterial standard (1,000/100 ml log mean) established for this reach [Figure 16]. Immediately downstream from this station an irrigation drain discharged about 300 lb BOD/day, almost doubling the load carried by the river.

At 6th Avenue in the city of Greeley (RM 6.3) the stream showed the effects of several irrigation drains and Eaton Draw. The DO values were below saturation levels, but well above the DO criterion of 5.0 mg/l. The fecal coliform standard was violated at this station (log mean density 3,200/100 ml).

Effects of the Greeley municipal wastewater treatment plant (RM 5.3) were evident at RM 5.2 and 0.5. The Greeley plant discharged from 10,000 to 22,000 lb of BOD per day into the river (treatment efficiency varying from 25-60 percent). At these stations DO levels ranged from 32 to 84 percent of saturation and the DO standard (3.0 mg/l) was violated at RM 0.5.

Chemical [Table D-6] and bacteriological findings [Figure 16] indicated that the Cache la Poudre was grossly polluted downstream from the Greeley discharge. The murky water smelled of sewage, and rich organic sludge beds blanketed most of the stream bottom. These sludge beds constituted a violation of sections B and D of the Basic Standards. Sludgeworms were numerous (22,810/ft^2) because of large amounts of available food in the sludge bed habitat. Fish populations near the mouth of the Cache la Poudre consisted of forage species; no game-fish were found.

During September, 1965, studies conducted in the Cache la Poudre River revealed that water quality was good at Bellvue but deteriorated downstream. As the river flowed through Greeley, this degradation increased because of the waste discharge from the municipal treatment plant. Additional causes of this degradation stem from numerous runoffs from irrigation and other agricultural operations. Comparison of the 1964-66 survey findings with those of the 1971 survey indicated that the quality of the river has not substantially improved in six years. [In Figures 17 to 19 are summarized the net pollutional effect on the algae in 1966, and these results are compared with conditions in 1971.]

Fall Survey (December 6, 7 and 13-15, 1971)

The Cache la Poudre River was surveyed from upstream of Eaton Draw (RM 7.0) downstream to the mouth in order to ascertain the combined effect caused by waste discharges from both the Great Western Sugar Company (Greeley) mill and the Greeley municipal treatment plant.

Upstream of Eaton Draw, the Cache la Poudre River was moderately polluted [Table D-7]. Dense growths of algae (3.8 million cells/in^2) were

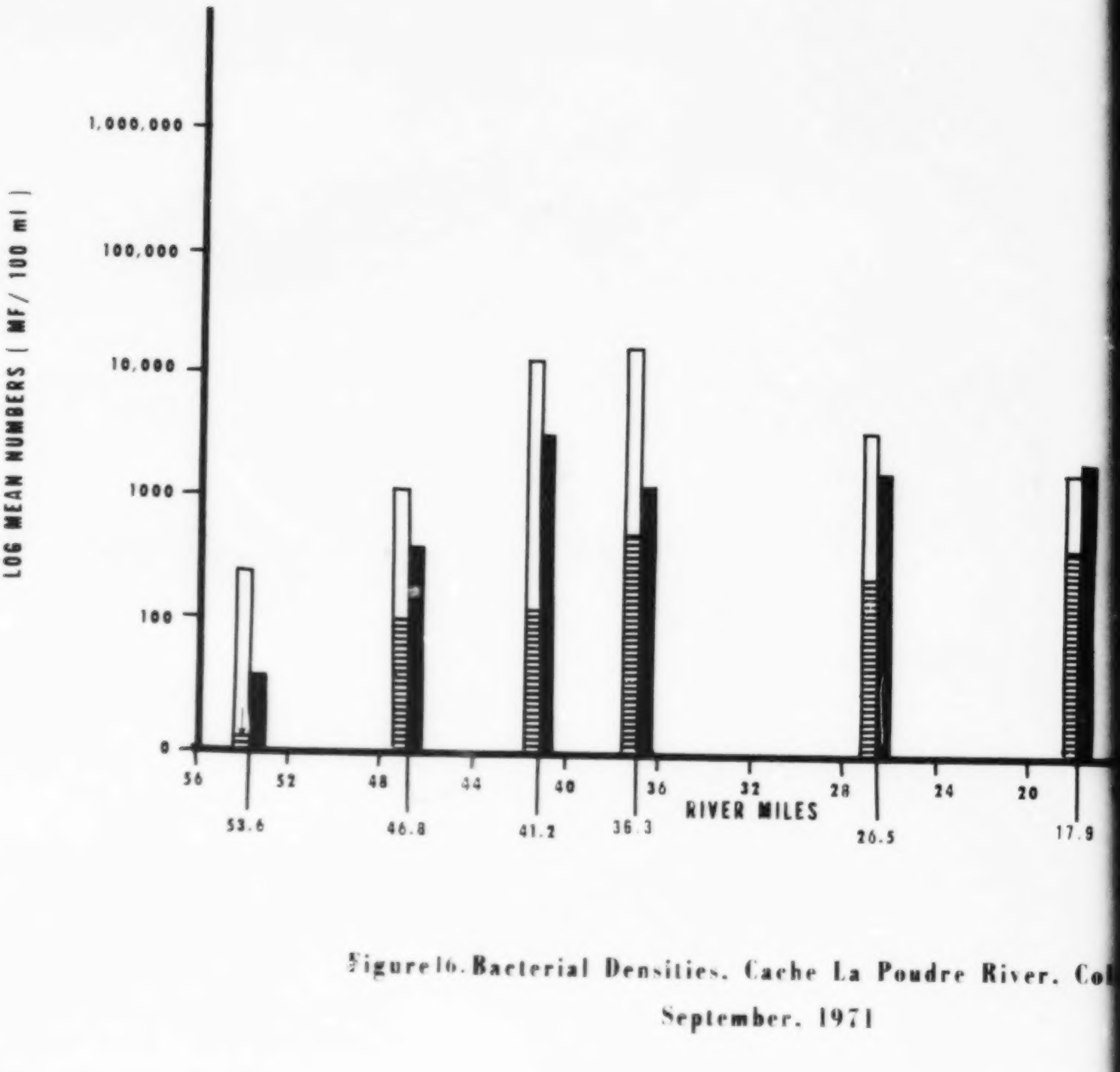
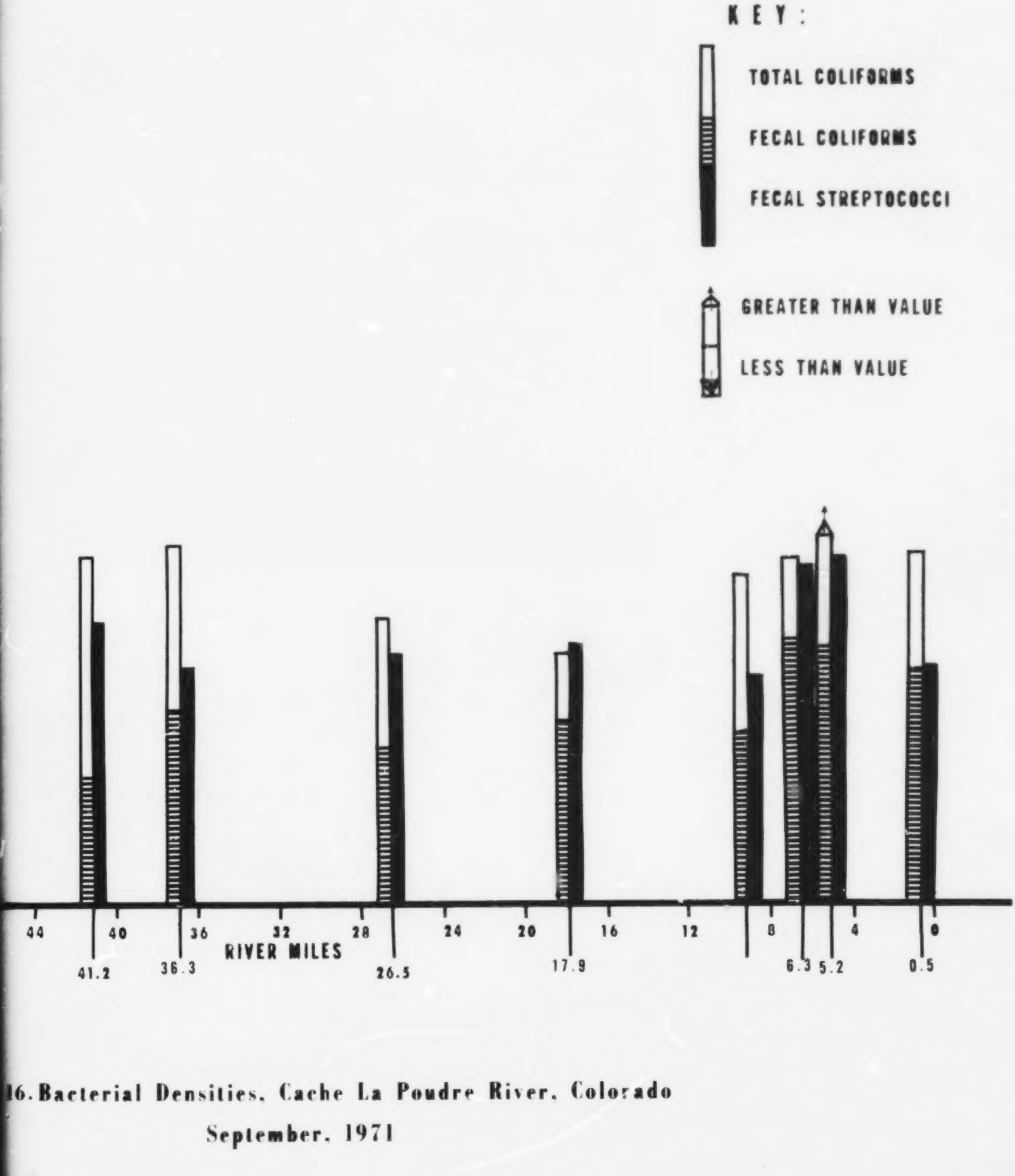


Figure 16. Bacterial Densities. Cache La Poudre River. Co

September. 1971



16. Bacterial Densities, Cache La Poudre River, Colorado September, 1971

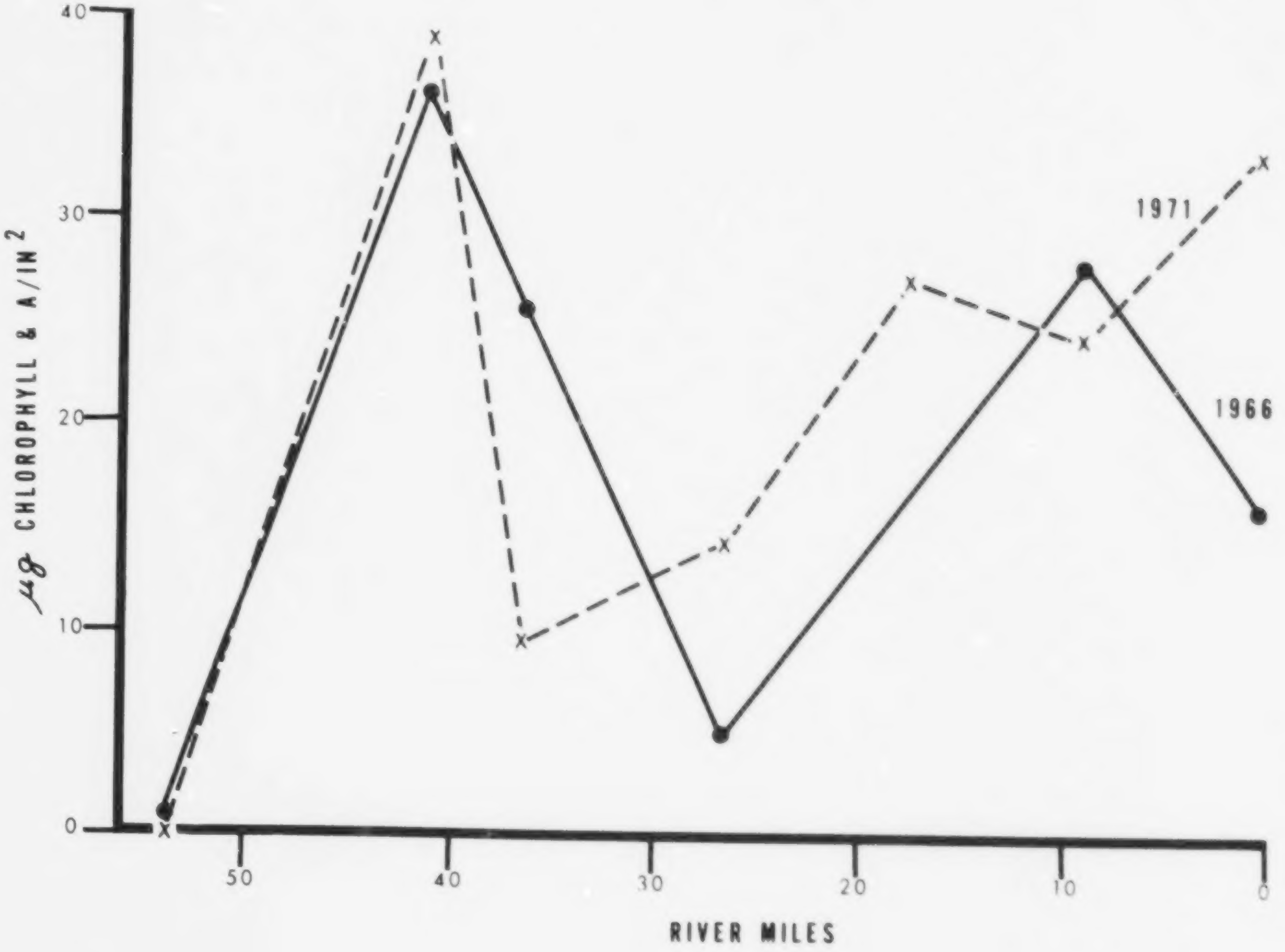


Figure 17 Attached Algae (chlorophyll $\underline{a}$) Cache La Poudre River, Colorado 1966 and 1971

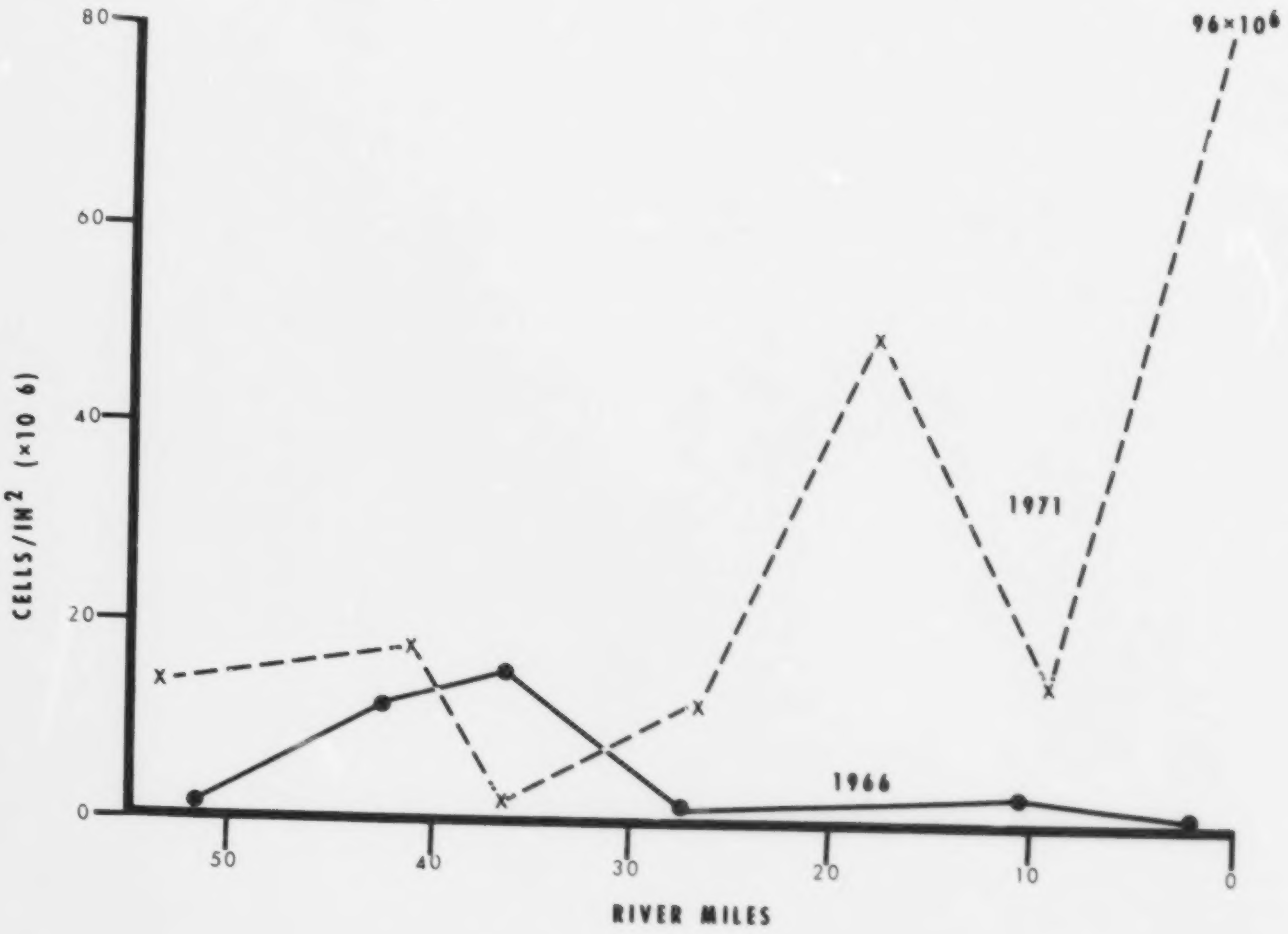


Figure 18 Attached Algae (cells/in^2) Cache La Poudre River, Colorado, 1966 and 1971

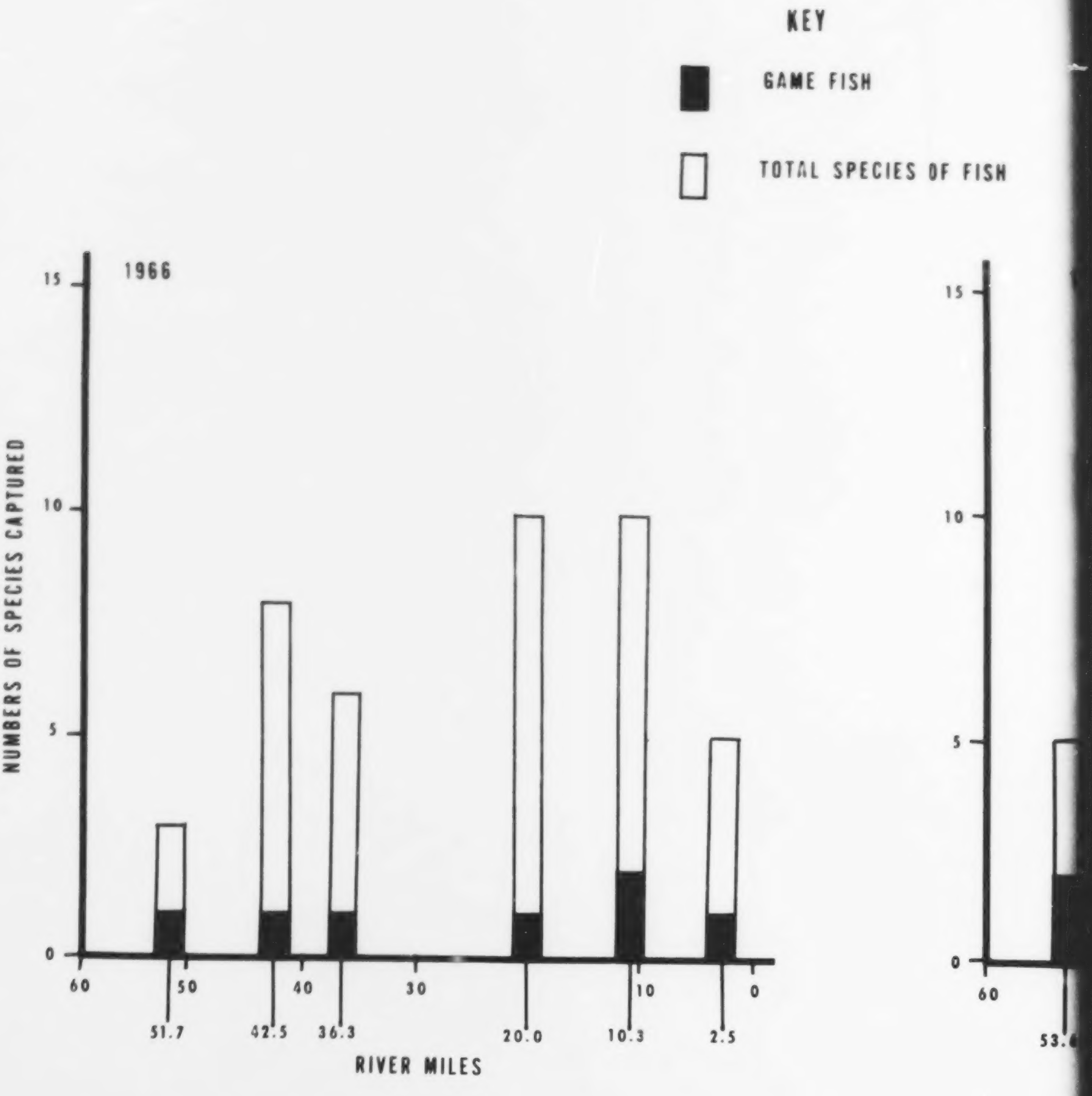
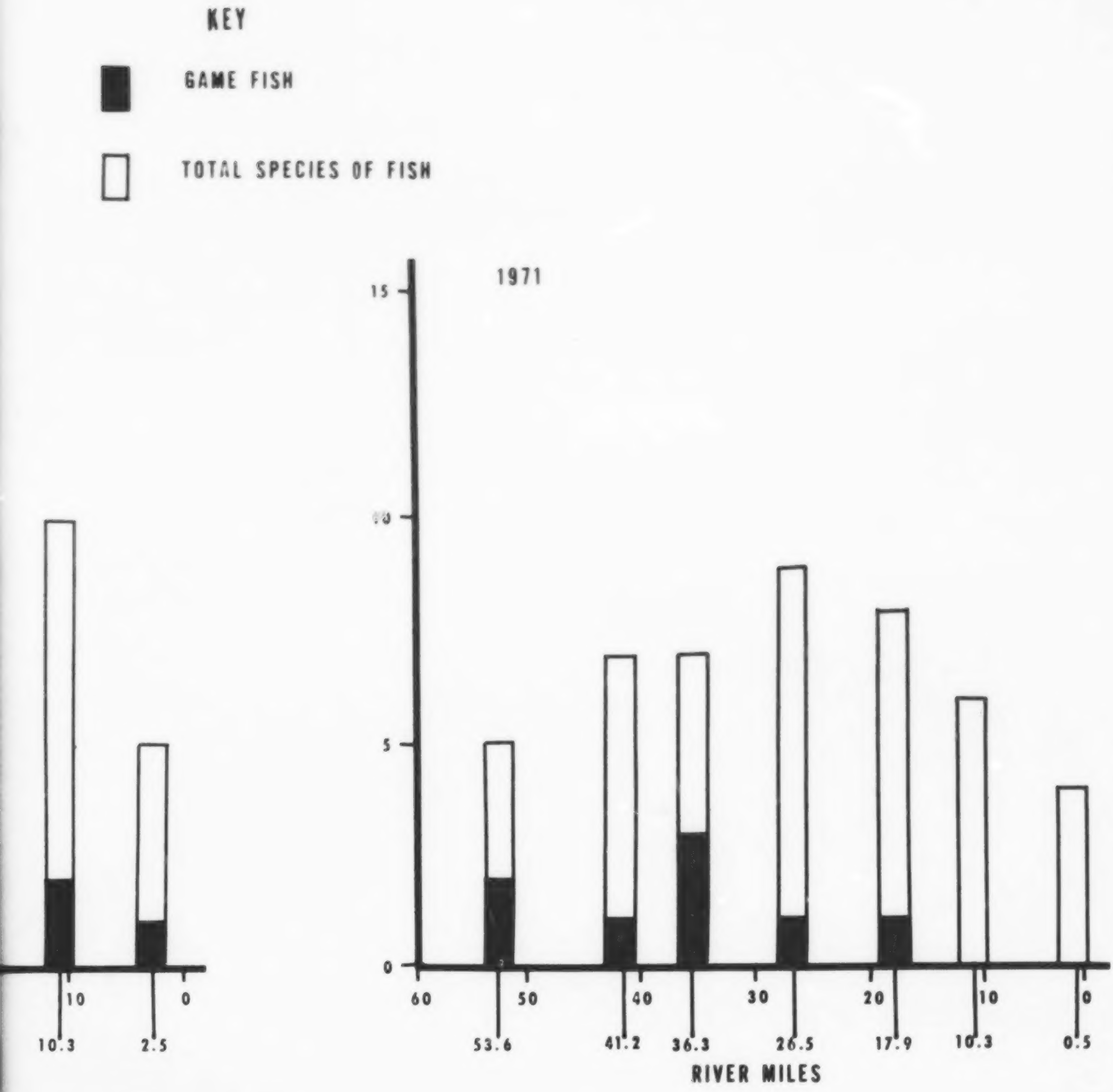


Figure 19. Fish Populations. Cache La Poudre River. Colorado.



tions.Cache La Poudre River.Colorado. 1966 and 1971 found at RM 7.0. Bacteriological studies showed log mean total- and fecal-coliform bacteria densities of 1,800 and 150/100 ml, respectively [Table E-6]. Although DO and coliform levels were well within the established standards, organic enrichment affected the benthos. Sludgeworms and facultative or pollution-tolerant fly larvae accounted for 95 percent of the bottom animals collected.

Eaton Draw was surveyed from upstream of the Great Western mill at Eaton (RM 6.9/7.2) and downstream to its mouth (RM 6.9/0.1) from November 30 to December 4, 1971. The upstream station had an average BOD value of 3.4 mg/l [Table D-7] with the DO ranging from 8.3-10.5 mg/l. The log mean bacterial densities were 920/100 ml fecal coliform and 16,000/100 ml fecal streptococci. At the time of the survey the Great Western mill (Eaton) and the community waste treatment plant (RM 6.6) discharged approximately 600 lb BOD (500 and 100, respectively) into Eaton Draw.

Effects of these waste discharges to Eaton Draw were evident at RM 6.5. There the DO was found to be 3.0 mg/l and the BOD as high as 36 mg/l. At the mouth of the draw the DO neared saturation levels (9.1 - 10.0) and the BOD averaged 14 mg/l (range -- 12 to 18 mg/l). Bacterial densities were 500 fecal coliform and 6,800/100 ml fecal streptococci. Flows from Eaton Draw, during December 6-7 and 13-15, 1971, averaged about 11 cfs.

The poor water quality of the Cache la Poudre River at 6th Avenue (Greeley) was similar to that observed upstream of Eaton Draw. Changes in the benthos community were limited primarily to a reduction in numbers [Table G-11] because of different substrate (more sand and less sludge).

The BOD levels had increased slightly (5.0 mg/l to 8.5 mg/l), attributable to inflows from Eaton Draw. Log mean total coliform densities were 1,900/100 ml. DO levels and fecal coliform densities met the criteria.

As a result of the Great Western (Greeley) discharge (RM 4.3) severe pollution conditions continued to exist near the mouth of the river (RM 0.5). This Great Western sugar-beet processing mill discharged about 26,000 lb of BOD daily into the stream. The fecal coliform bacteria had increased by five times, to 19,000/100 ml. The river was murky and covered with slimes, primarily *Sphaerotilus*. There was an increase in *Sphaerotilus* growth downstream from the municipal (Greeley) treatment plant and the mill wastewater discharge [Figure 20]. Effects of the Great Western mill wastes on the benthos were masked by the upstream sewage discharge; sludge deposits cover much of the stream the year around. These sludge deposits were attributable to sugar beet processing wastewater discharges and sewage; no specific waste sources could be isolated as the principal contributor.

The BOD in the Cache la Poudre River near the mouth varied from 30 to 135 mg/l. The swift and shallow nature of the Cache la Poudre River prevented DO depletion. Dissolved oxygen saturations varied from 48 to 63 percent (5.1 - 7.1 mg/l) but exceeded the minimum requirements of the Standards.

A 1963-64 survey[4/] revealed that the river in the Greeley area was degraded by residual wastes. In its course through Greeley, the river water quality was markedly affected; the BOD increased from approximately 200 to 350 mg/l (measured at both RM 9.4 and 2.9, respectively). The lower

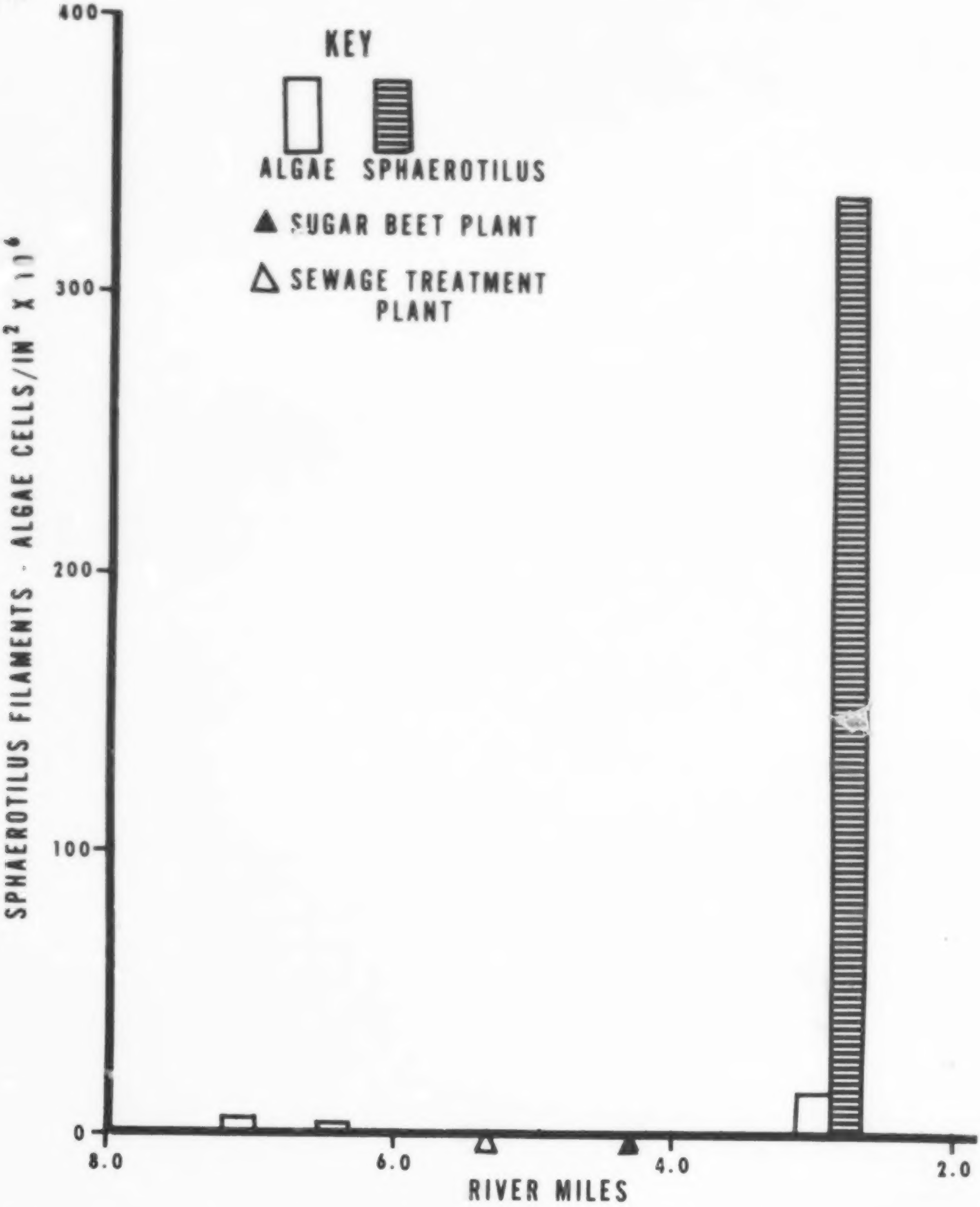


Figure 20 Periphyton from Glass-Slide Substrates - Cache La Poudre River at Greeley, Colorado Nov. 1971

portion of the Cache la Poudre River represented the most severe case of surface water pollution existing in the entire South Platte River Basin in 1964.

Since the closure of the Great Western mill at Windsor (1966), the mill at Eaton has installed pollution control measures; the Monfort plant presently diverts all wastes to the Greeley wastewater treatment plant. In spite of the significant reduction in waste loads, the lower reach (RM 5.3 to the mouth of the Cache la Poudre) remained severely polluted. In order to protect and enhance the water quality of the lower river and if existing water quality standards are to be met, the present waste loads from both the Greeley treatment plant and the Great Western mill must be substantially reduced.

H. SOUTH PLATTE RIVER

The section of the South Platte River studied lies between Waterton (RM 339.2), and the I-80 Bridge (RM 81.1) near the Colorado-Nebraska state line.

Summer Survey (August 30-September 16, 1971)

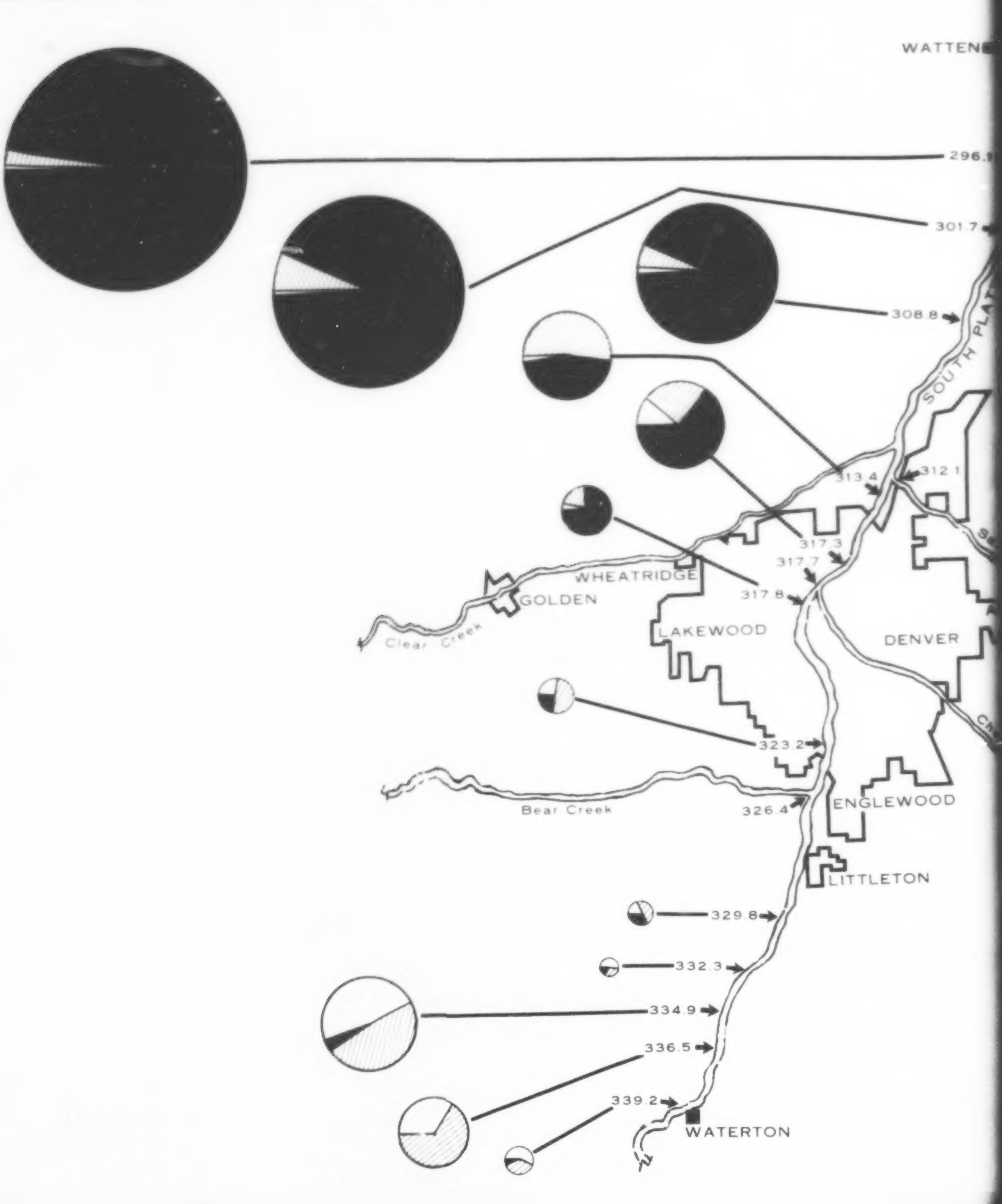
The South Platte River at Waterton (RM 339.2) was of good quality and did not have high numbers of coliform bacteria. The benthos consisted of a variety (15 kinds) of organisms, in low numbers [Figure 21], most of which were intolerant of organic pollution. The river had a game-fish population of rainbow and brown trout. Flows at this station (USGS Gage) averaged 320 cfs during the (August 30 to September 3, 1971) sampling period.

Downstream, at Blakeland Highway (RM 336.5), the river continued to have good water quality [Table D-8]. The diversity of benthos increased to 21 kinds; pollution-sensitive and facultative forms were prevalent. Game-fish, such as rainbow trout and black bullheads, inhabited this reach.

At the time of the 1966 studies,[7] the Peter Kiewit and the Cooley sand and gravel companies (RM 335 and 332.5, respectively) were discharging highly turbid wash water directly to the South Platte River. Levels of suspended solids as high as 3,586 mg/l were recorded in the river at RM 335.9 in 1966 and adversely affected aquatic biota for six miles downstream [Figures 22 and 23]. Since then, both companies have constructed settling ponds that effectively reduced the solids content in the river and damages to the biota. Game-fish did not inhabit this reach in 1966, but they are now present.

At RM 334.9 no damages to aquatic biota from gravel washing were evident. Suspended solids levels ranged as high as 50 mg/l. Benthos communities were relatively diverse (14 kinds) and consisted of congruous assemblages in moderate densities (337/ft^2). Game-fish (black bullheads and channel catfish) were collected from this reach.

Damages to river biota from past gravel operations were still evident at RM 332.3 and 329.8 (Bowles Avenue). The river was not turbid (maximum suspended solids detected was 40 mg/l) and the bed of the South Platte River reach was covered with sand. This shifting sand provided poor habitat for benthic invertebrates, which are important as food for fishes. Benthos intolerant of organic pollution were found; brown trout inhabited


WATTEN
296.1
301.7
308.8
SOUTH PLAT
313.4
312.1
317.3
317.7
317.8
WHEATRIDGE
GOLDEN
Clear Creek
LAKEWOOD
DENVER
323.2
Bear Creek
326.4
ENGLEWOOD
LITTLETON
329.8
332.3
334.9
336.5
339.2
WATERTON

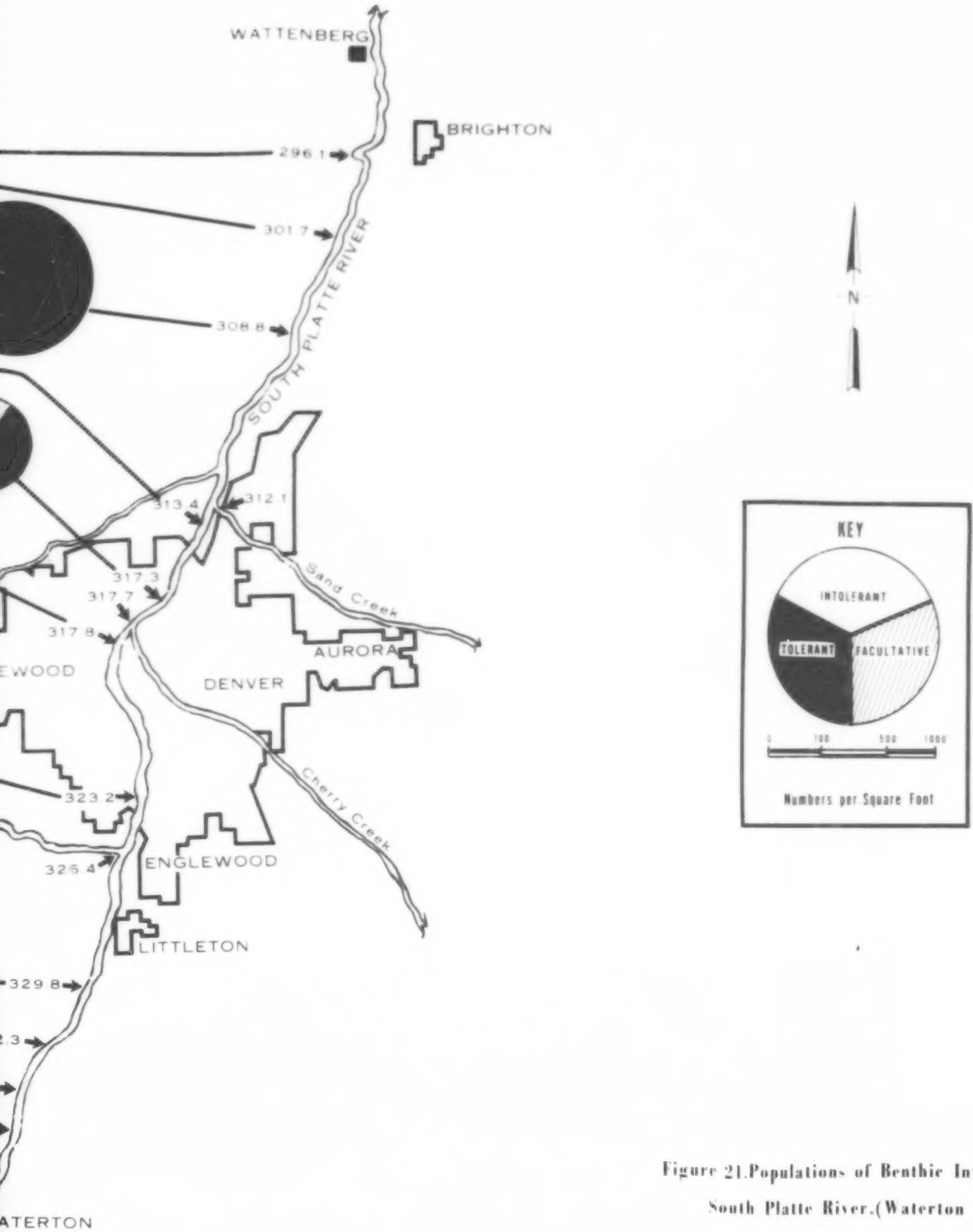
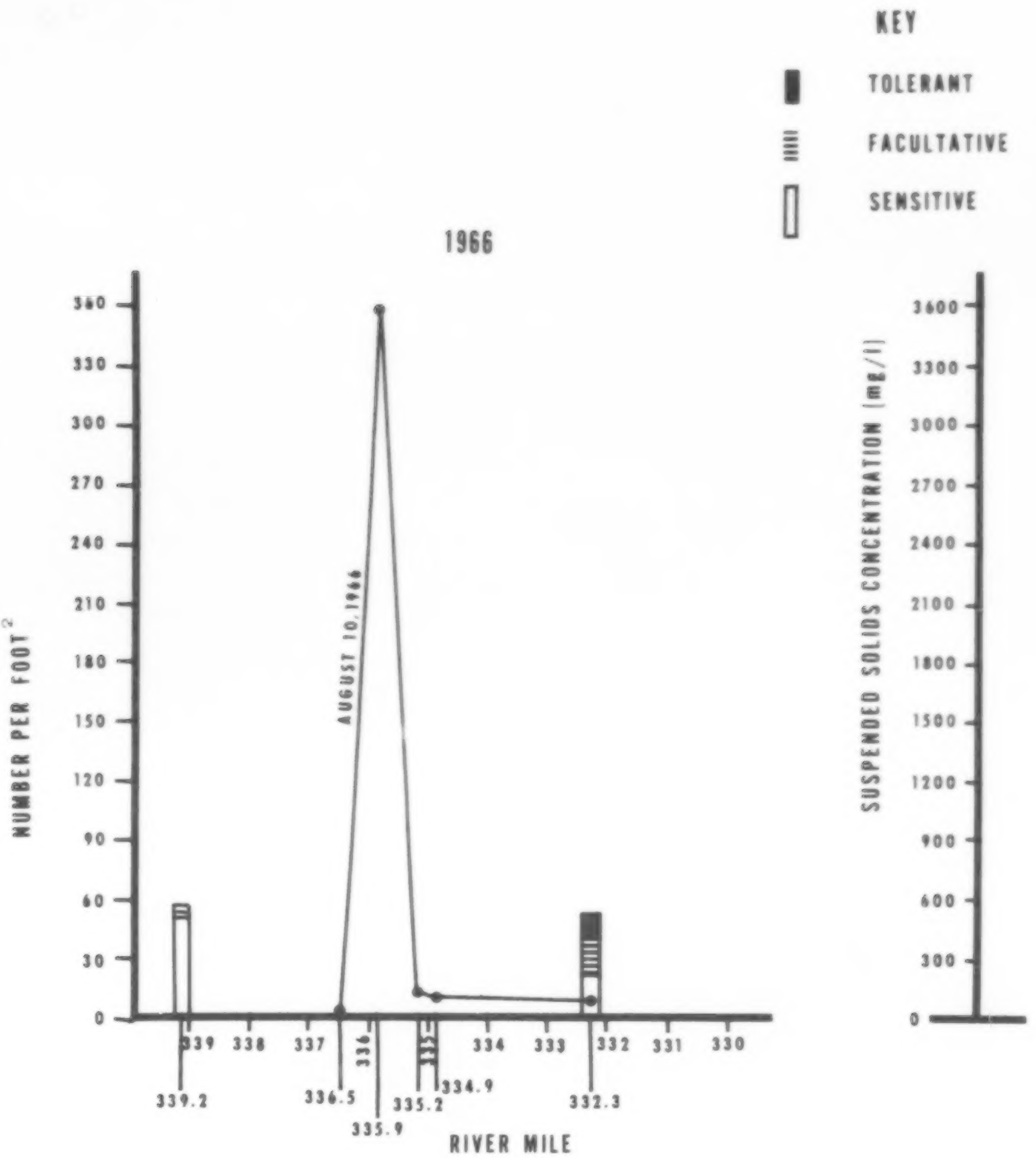
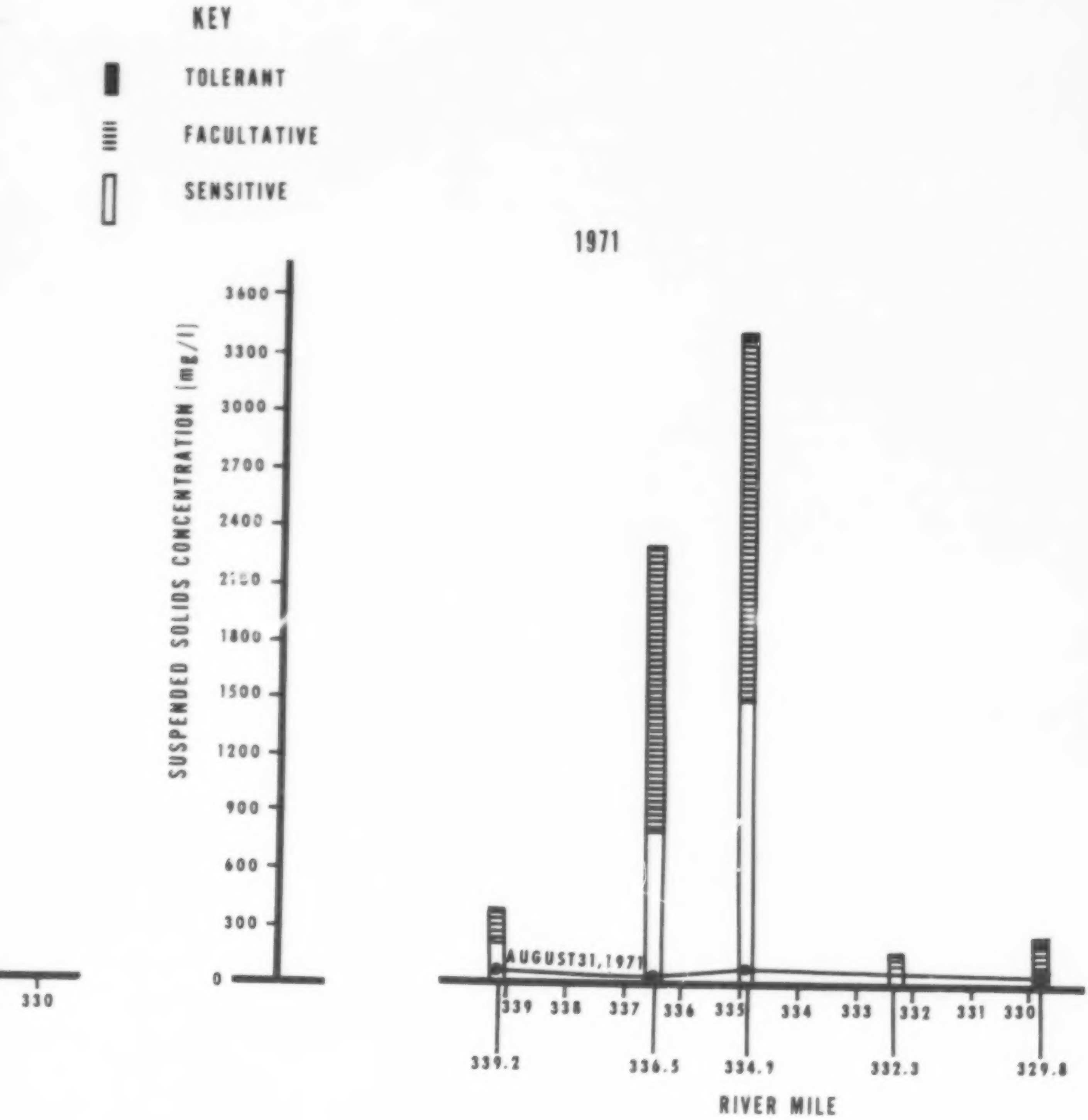


Figure 21.Populations of Benthic Invertebrates South Platte River.(Waterton to Brighton)



*VALUES PLOTTED ARE FOR DAY HIGHEST READING OCCURED

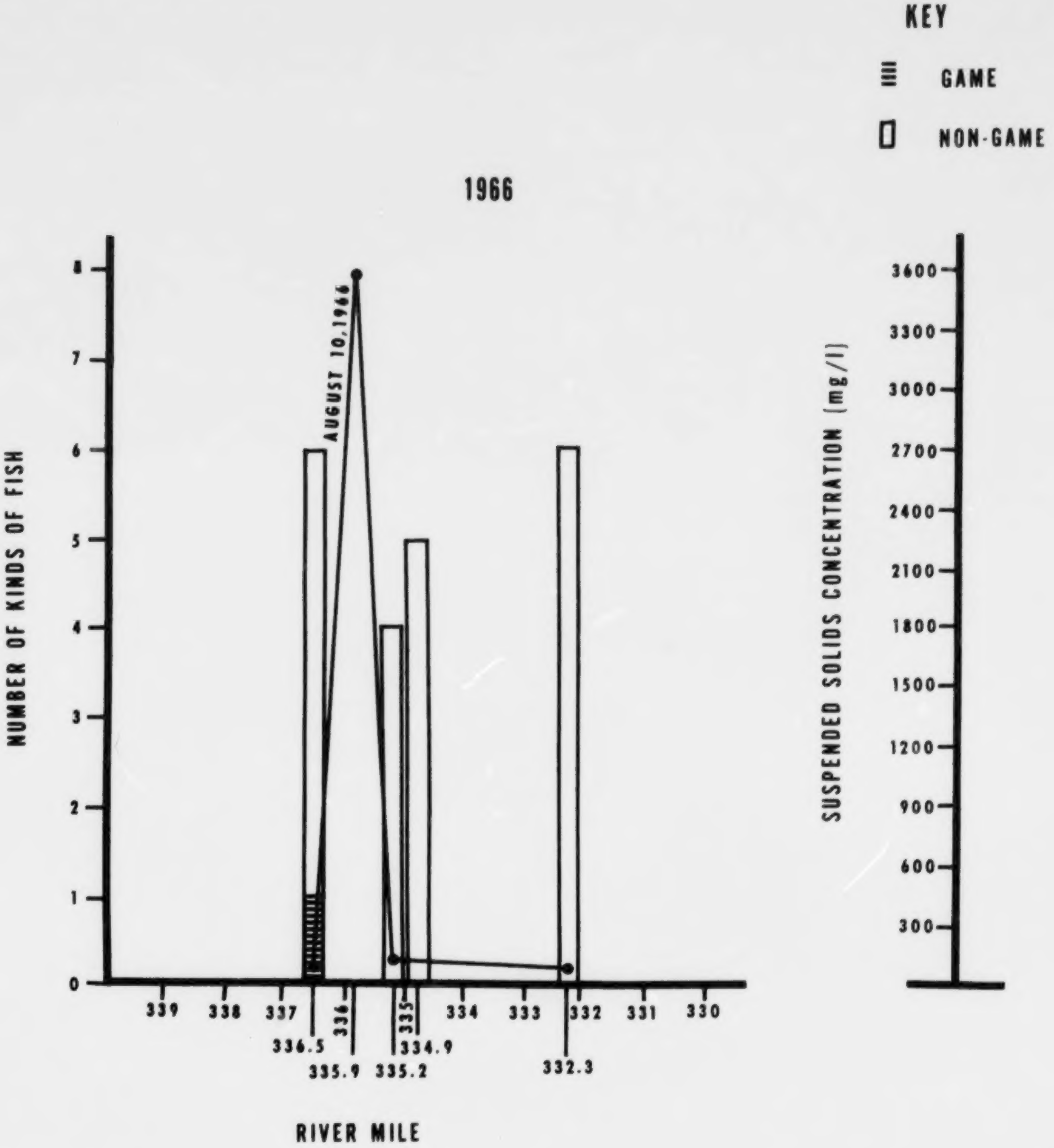
Figure 22. Benthos and Suspended Solids*,Waterton to Bowles Avenue,Sout



RED

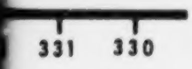
*.Waterton to Bowles Avenue.South Platte River.Colorado.1966 and 1971.

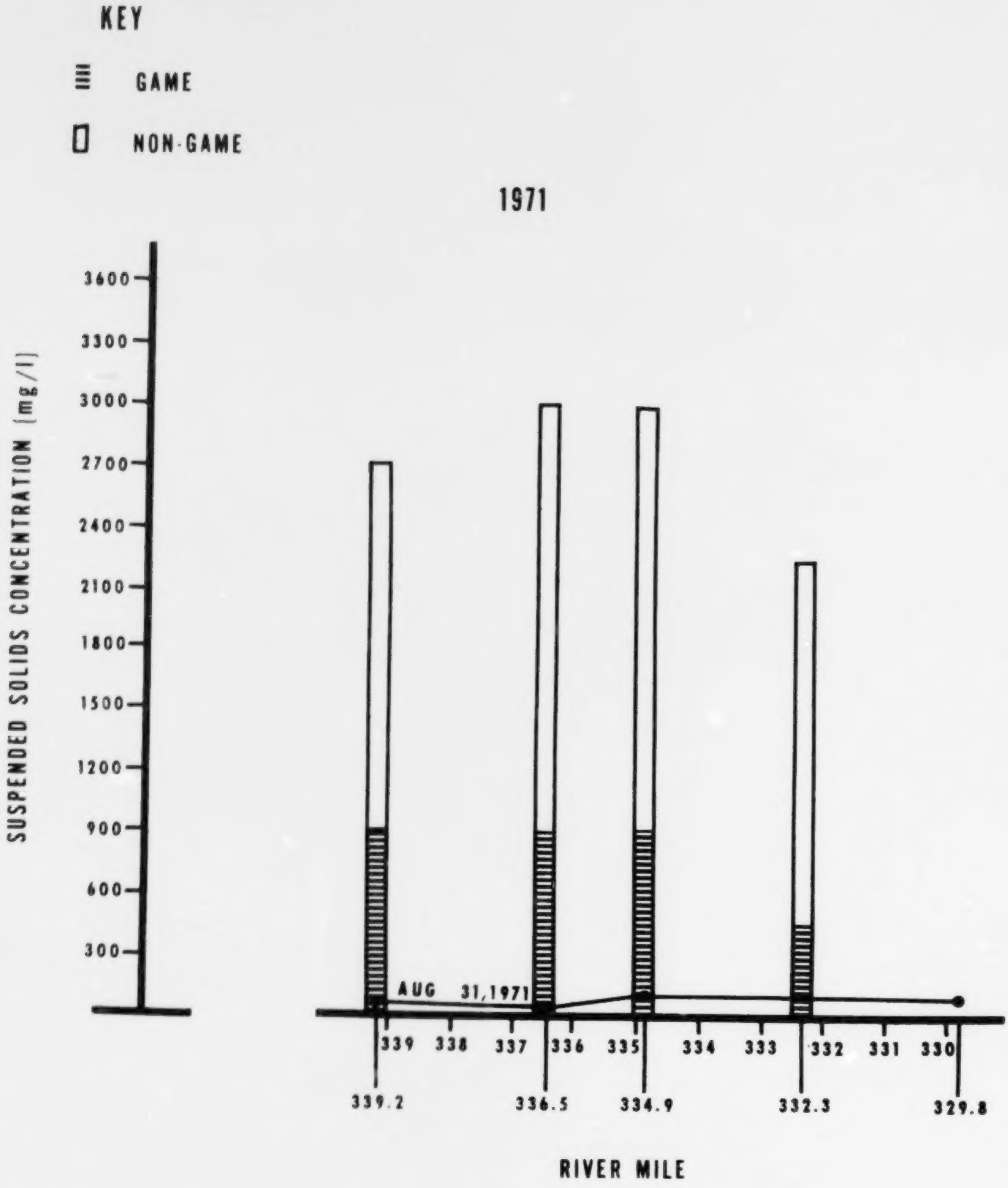
46-c



*VALUES PLOTTED ARE FOR DAY HIGHEST READING OCCURED

Figure 23. Fish Populations and Suspended Solids*. Waterton to Bowles Aven





OCCURED

ed Solids*.Waterton to Bowles Avenue.South Platte River.Colorado.1966 and 1971:

the upstream reach (RM 332.3). However, the numbers and varieties of benthic organisms were severely reduced in these reaches [Figure 21]. Thus, an important source of fish-food continued to be damaged in September, 1971.

Downstream the effluent from the Littleton Waste Treatment Plant enters the South Platte River at RM 327.6. An evaluation of this plant revealed that approximately 1,500 lb of BOD and 2,100 lb of suspended solids were being discharged into the river daily. At RM 326.4 Bear Creek joins the South Platte. Earlier in this report this creek was described as being enriched at its mouth.

Waste from the Englewood Waste Treatment Plant discharges to the river at RM 325.1. A previous investigation of this plant indicated that about 4,000 lb of BOD and 5,600 lb of SS were being discharged daily. The effects were evident at the Florida Avenue bridge (RM 323.2). The BOD increased on all sampling days and measured as high as 7.8 mg/l. Suspended solids increased to as high as 120 mg/l. Because these organic materials did not settle immediately to the river bottom, benthos were not severely affected in this reach. The benthos consisted of 15 kinds of organisms including several intolerant forms in low numbers [Figure 21].

During the studies[6/] in 1964-65, more than 130 wastewater outfalls were found along the South Platte River from Florida Avenue to the mouth of Cherry Creek (RM 317.7); nineteen of these were sampled and, of these, seven contained BOD in excess of 100 mg/l (four were greater than 400 mg/l). In combination, these various sources were contributing several thousand pounds of BOD to the river daily. It has been reported that the majority of these waste sources have (since the 1964-65 studies) been controlled through their connection to the Metro treatment plant.[11]

Organic materials settled on the river bottom, at RM 317.8, producing a habitat suitable for pollution-tolerant species. Caddisflies were eliminated; other intolerant forms constituted only three percent of benthic invertebrates (as compared with 23 percent at RM 323.2). Conversely, pollution-tolerant invertebrates increased from 21 to 75 percent of the total population.

Cherry Creek, described as severely polluted during the 1964-65 studies,[6] appeared moderately polluted at the mouth in 1971 [Tables D-1 and E-1]. Bacterial contamination was evident (log mean fecal coliform density was 780/100 ml). The benthic community was dominated by pollution-tolerant and facultative organisms, such as sludgeworms and midges. Intolerant caddisflies and mayflies constituted about one percent of the benthos.

The South Platte River remained degraded downstream from Cherry Creek. The benthos at RM 317.3 (19th Street bridge) were dominated by pollution-tolerant forms; the density of organisms did not increase materially. Flows, at this station, ranged from 291 to 344 cfs (average 307) from August 30 to September 3.

During the 1964-65 studies[6] there were about 100 storm sewers and outfalls located in the reach from Cherry Creek (RM 317.7) downstream to York Street (RM 313.4); twenty-five of these were sampled; several were found to contain BOD in excess of 250 mg/l and fecal coliform densities greater than three million MPN/100 ml, thus indicating that these discharges contained raw sewage. One of these outfalls was located at 47th Avenue.

On several occasions, during August and September 1971, raw sewage was observed being discharged from this outfall. Raw sewage was also observed overflowing at a manhole near Franklin Street (RM 314.3). It was evident from the huge sludge bank just downstream that there had been large overflow volumes entering the river for a prolonged period. Water samples collected at the York Street-South Platte station were severely contaminated by fecal matter. The number of fecal coliform bacteria was greater than 13,000/100 ml (log mean) which is in violation of the standard of 1,000/100 ml established for this reach. The levels of suspended solids were high in this reach. Levels of DO at the York Street station ranged from 5.6 to 7.4 mg/l.

Downstream (RM 312.5) the Cherokee Plant of the Public Service Company of Colorado discharged about 10 mgd of cooling water into the South Platte River. Suspended solids in the discharge were measured at 80 mg/l.

The Metropolitan Denver Sewage Disposal District #1 Plant (RM 312.2) treats the majority (more than 80 percent) of the Denver area domestic wastes and is one of the most significant pollution sources in the South Platte River Basin. Wastewaters discharged daily from August 30 to September 3, 1971 contained about 60 mg/l BOD (62,000 lb/day) and 85 mg/l suspended solids (88,000 lb/day). During an in-plant survey in early August, bacteriological analyses of the effluent indicated total coliforms ranged from 6,600 to 14,000,000/100 ml, 230 to 430,000/100 ml of which were fecal coliform bacteria. Adequate disinfection was not being practiced at this plant.

During the August 1971 survey the flow in Sand Creek (RM 312.1/0.1) was primarily overflow from the Burlington Ditch which contained raw sewage discharges. The creek smelled of sewage and was gray in color. Densities of total coliform bacteria were greater than 110,000/100 ml (log mean value), and the log mean level of fecal coliform bacteria was 8,800/100 ml [Table E-1]. Benthic invertebrates, dominated by pollution-tolerant sludgeworms, inhabited the creek bottom in dense populations ($1,494/ft^2$). The diversity of organisms was limited to six kinds; most were pollution-tolerant or facultative forms.

The South Platte River became severely polluted downstream from Metro and Sand Creek. At RM 311.5 the odor of sewage was strong and the water was gray, turbid, and covered with foam. The river bed was blanketed with organic sludge. The benthic community was limited to seven kinds and consisted mostly of pollution-tolerant sludgeworms and snails. Violations of Sections B and D of the Basic Standards were evident.

Pollutants discharged to the South Platte River by Clear Creek (RM 311.1) additionally degraded the water quality of the South Platte River. Pollutants from all these sources (Metro, Sand Creek, and Clear Creek) had settled to the river bottom, forming sludge beds that were evident from Clear Creek to Ft. Lupton -- approximately 23 river miles. The densities of coliform bacteria were equivalent to those of many sewers; fecal coliform bacteria numbered more than 7,900/100 ml and total coliform bacteria numbered more than 320,000/100 ml [Figure 24]. Dissolved oxygen values were depressed to levels that cannot be tolerated by fish for extended periods [Table D-8].

Downstream from the Metro discharge, the DO approached the criterion of 3.0 mg/l at 88th Avenue, Brighton, and Fort Lupton and fell below the

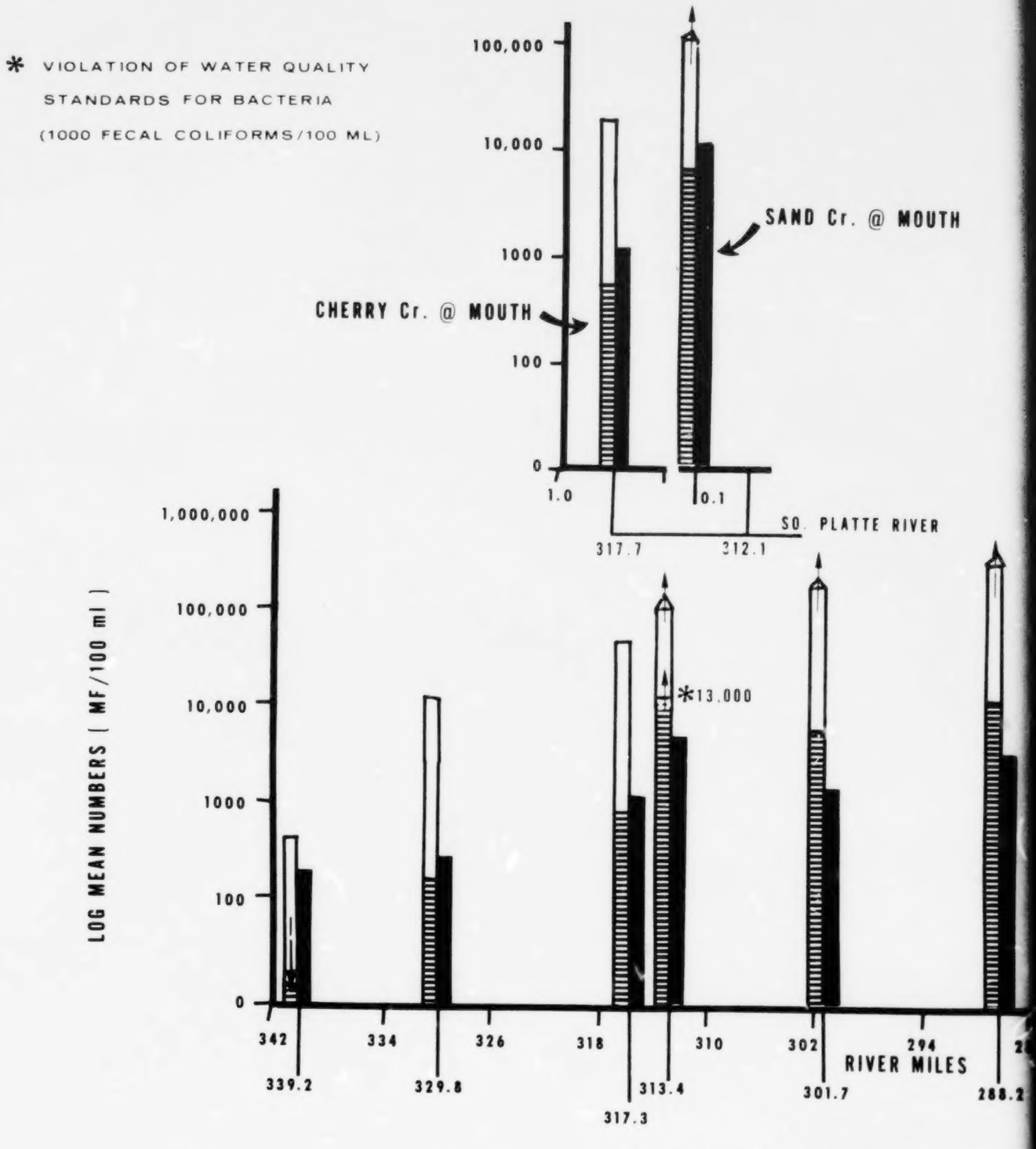
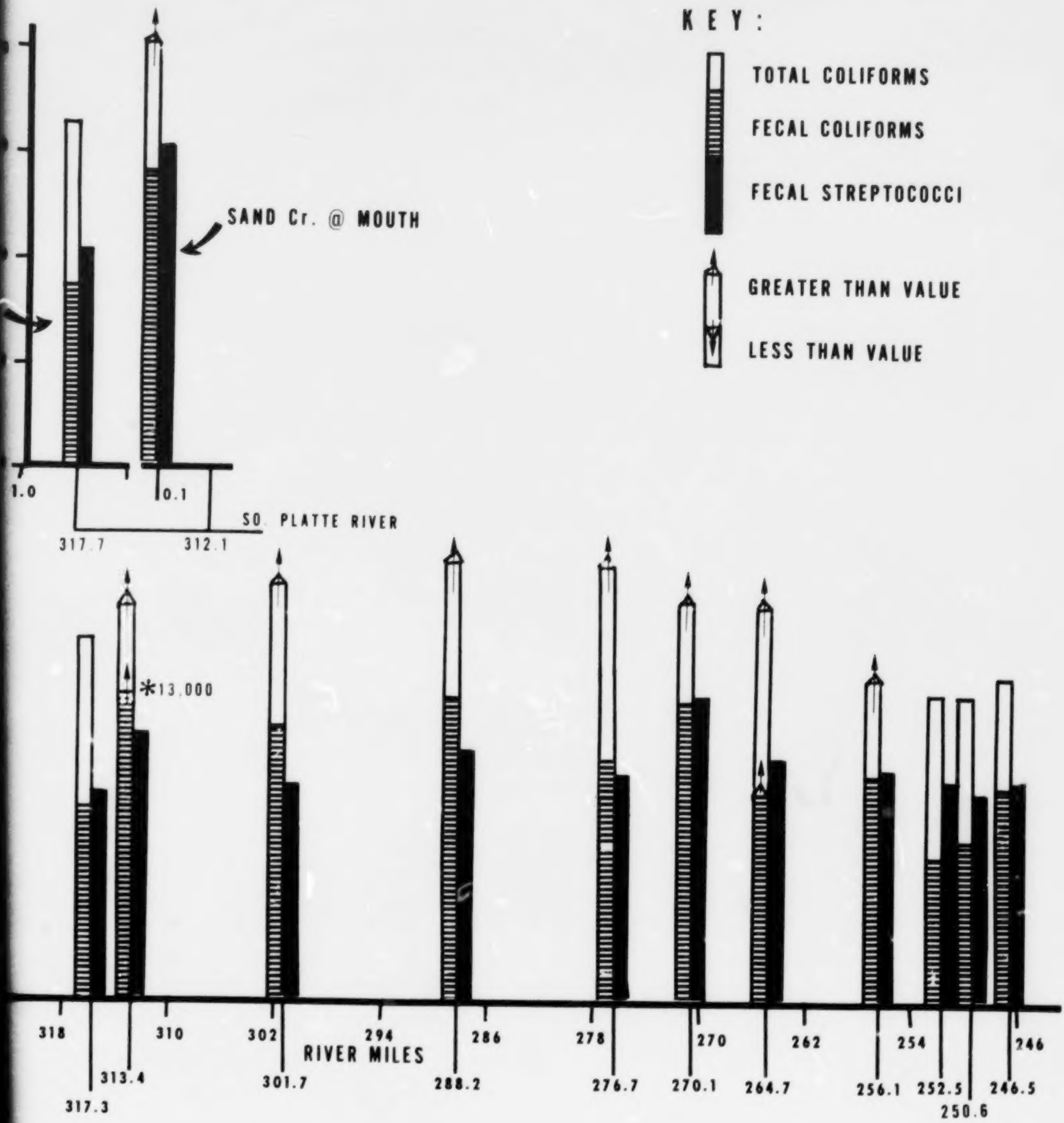
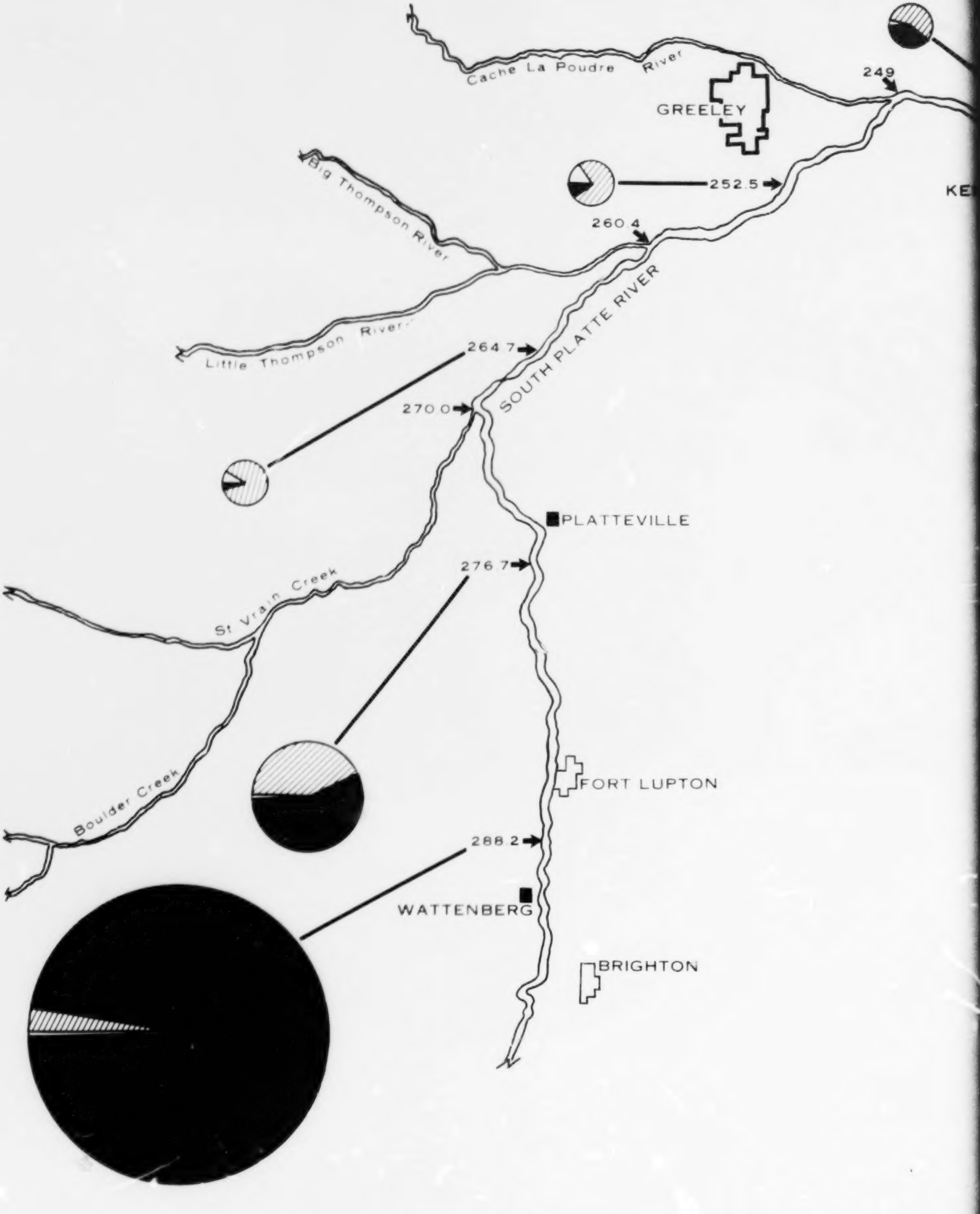


Figure 2 1 Bacterial Densities. South Platte River From Waterton to



South Platte River From Waterton to Kersey, Colorado September, 1971


Cache La Poudre River
GREELEY
249
252.5
KE
Big Thompson River
260.4
Little Thompson River
SOUTH PLATTE RIVER
264.7
270.0
PLATTEVILLE
276.7
St Vrain Creek
Boulder Creek
FORT LUPTON
288.2
WATTENBERG
BRIGHTON

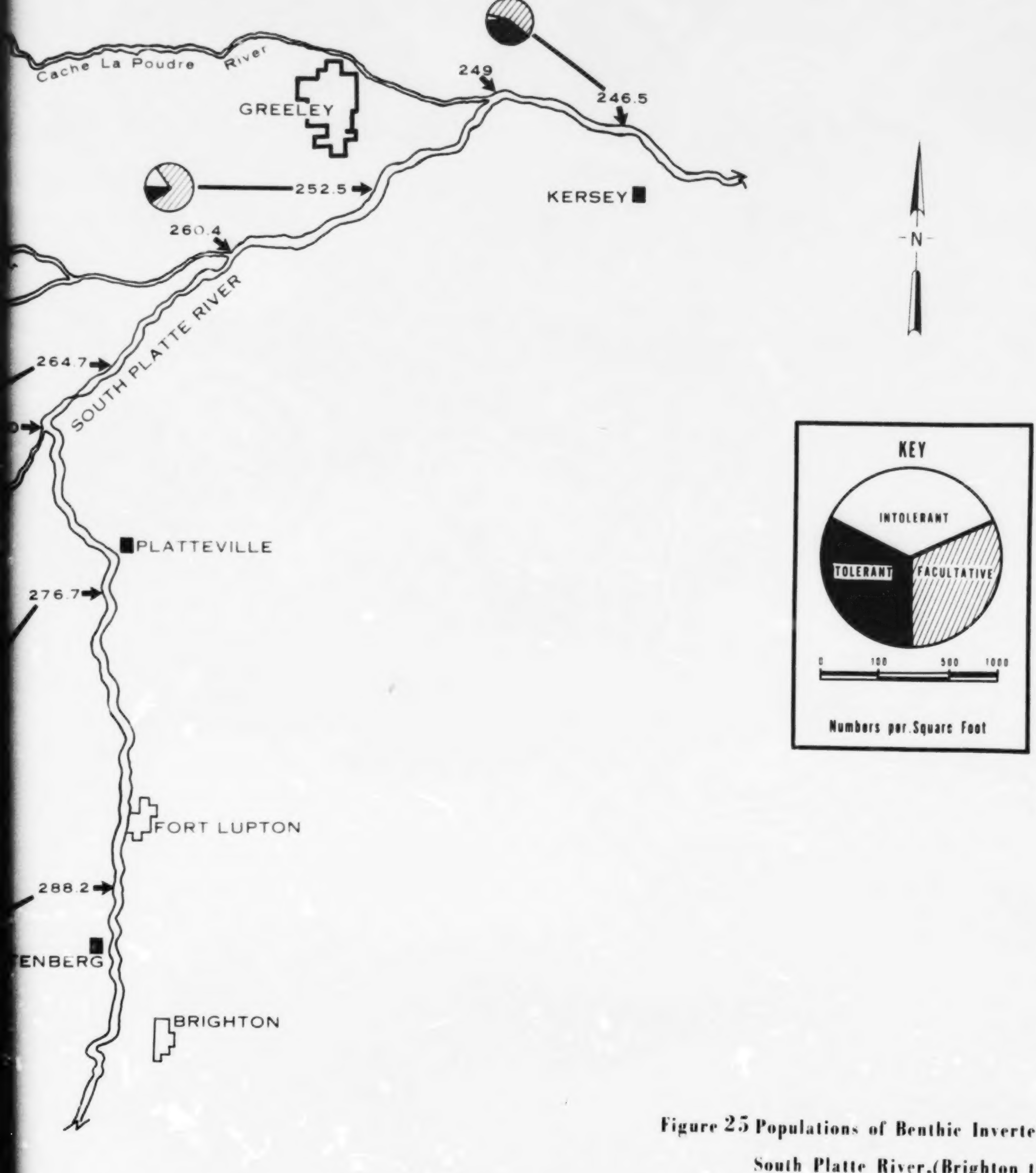


Figure 25 Populations of Benthic Invertebrates South Platte River. (Brighton to Kersey)

criterion at Henderson (dissolved oxygen levels were measured during a 24-hour period at these stations). The concentrations of suspended solids were extremely high; much of this material was in the form of organic compounds. Total organic carbon levels were highest when river flows were greatest, thus indicating that settled materials were being resuspended by high-flow turbulence. These pollutants were damaging to South Platte River biota.

At 88th Avenue (RM 308.8) the number of benthic invertebrates increased to 732/ft^2 with a variety of only eight kinds. Ninety-two percent of these organisms were pollution-tolerant sludgeworms. This condition persisted at Henderson (RM 301.7). Downstream from this station the effluent from the South Adams Water and Sanitation District plant (RM 306.7) discharged to the South Platte River. An in-plant evaluation revealed that the effluent had daily BOD and SS loads of 940 and 2,200 pounds, respectively. The waste load from this plant and the residual wastes from the Metro Denver plant sustained pollution conditions at Henderson (RM 301.7). Benthic organisms increased to 1,424/ft^2 with a diversity of six kinds. Pollution-tolerant sludgeworms accounted for more than 90 percent of the benthos. Fish collected at Henderson consisted of the non-game species. Flows at this station ranged from 275 to 794 cfs (average, 489) during this study period (from August 30 to September 3, 1971).

Effluent from the Brighton waste treatment plant enters the stream at RM 295.8. The plant discharged approximately 600 lb BOD and 900 lb suspended solids per day during the in-plant survey. The Fort Lupton plant (RM 288.6) discharged negligible amounts of BOD and suspended solids. A large feedlot (Mancini Feedlot) borders the South Platte River between Brighton and Fort Lupton. The extent of pollution from this source was not determined.

Conditions at Brighton (RM 296.1) and Fort Lupton (RM 288.2) were similar to those noted at Henderson. Benthic organisms increased to $2,292/ft^2$ at Brighton and $3,268/ft^2$ at Fort Lupton. Pollution-tolerant sludgeworms accounted for more than 90 percent of the benthos.

At Platteville (RM 276.7) the quality of the South Platte River remained degraded. Fecal-coliform bacteria densities were less than values recorded upstream, but averaged 4,700/100 ml. The BOD values ranged from 5.4 to 9.6 mg/l, but DO levels (4.0-6.6 mg/l) were not severely depressed. The density of benthic invertebrates decreased to $409/ft^2$ and tolerant forms made up 57 percent. Only ten kinds of invertebrates inhabited this reach; most were tolerant and facultative forms [Figure 25]. All fish collected were of the non-game species.

The reach of river from Platteville (RM 270.1) to just downstream from the mouth of the Big Thompson River (RM 256.1) was surveyed during September 7 to 10, 1971. The chemical quality was similar to that previously recorded upstream [Table D-8] at RM 276.1. However, the number of fecal coliform bacteria increased to 11,000/100 ml and the DO level was below 4.0 mg/l on one occasion.

St. Vrain Creek enters the river at RM 270.0. Downstream from the St. Vrain confluence at the Colorado Highway 60 bridge, the quality of the river improved because of the diluting effect of the St. Vrain waters.

The South Platte River contained less suspended solids (10-130 mg/l) at RM 264.7 than at 270.1 (20-200 mg/l) and DO levels exceeded 5 mg/l. The community of benthic invertebrates, although dominated by facultative organisms and consisting of only twelve kinds, contained several kinds of intolerant organisms. The density of benthos decreased to only 69 organisms/ft^2 in this reach.

The South Platte River was degraded, but not severely polluted, from RM 264.7 to downstream from the mouth of Big Thompson River RM 256.1. Log mean coliform bacteria levels were excessive (total greater than 34,000, fecal; 2,400/100 ml) at RM 256.1, between LaSalle and Evans. The BOD ranged from 3.1 to 12 mg/l at the latter station; the DO levels ranged from 5.6 to 7.5 mg/l, i.e., above the criterion of 3.0 mg/l.

From September 13 to 16, 1971, the reach of the South Platte River extending from RM 252.5 (east of Evans) downstream to Kersey (RM 246.5) was surveyed. Flow conditions were affected by precipitation (an increase from 50 to 150 cfs) during the survey period. The quality of the South Platte River east of Evans (RM 252.5) was generally better than at RM 256.1. Because of high flows, only six kinds of benthic invertebrates were collected, at a density of 74/ft^2. Of these, approximately equal proportions (13 percent) were tolerant and sensitive forms. Fish populations consisted of non-game species, such as longnose suckers, minnows, and carp. The BOD was low (2.0 mg/l average) and the DO levels ranged from 7.6 to 8.8 mg/l.

At RM 250.6 the quality of the river was similar to that recorded at RM 252.5. The DO levels were well above the Basic Standard (range 6.9 to 8.5 mg/l).

At Kersey (RM 246.5) the South Platte River again became severely polluted as a result of the Cache la Poudre River inflow. The total coliform (33,000/100 ml) and fecal coliform bacteria (2,000/100 ml) were excessive. Because of a shifting sand substrate the density of benthic organisms was recorded at only $58/ft^2$. Pollution-tolerant sludgeworms increased to 37 percent of the population and intolerant forms decreased to three percent.

A limited survey, during September 27-29, 1971, was conducted from Ovid, Colorado (RM 95.4) to the I-80 bridge in Nebraska (RM 81.1) in order to ascertain bacteriological conditions prior to the seasonal operation of the Great Western Sugar Company mill at Ovid. Bacteriological analyses indicated that the log mean total and fecal coliform bacterial densities were less than 2,000 and 250/100 ml respectively, at all stations.

In summary, the water quality of the South Platte River in 1971 was similar to that found in 1964 and 1966, with the exception of one area. In the reach near the Cooley and the Kiewit sand and gravel companies (RM 335 and 332.5, respectively) the loads of suspended solids have decreased; the layer of sand on the river bed should eventually dissipate sufficiently for the establishment of a desirable benthic biota and more game-fish.

Fall Surveys (November - December, 1971)

From November 17 to 21, 1971, a bacteriological survey was conducted from the 19th Street (RM 317.3) location to the Colorado Highway 224 (RM 310.9) crossing. Effects of waste discharges, primarily that from the Metropolitan Denver Sewage Disposal Plant (Metro), on the quality of the

South Platte River were ascertained [Table E-7]. The survey[12] indicated that violations of the bacteriological standard (1,000/100 ml log mean) were occurring at the York Street location. Downstream from the Metro discharge the log mean fecal-coliform bacteria densities exceeded 7,000/100 ml. *Salmonella*, a pathogenic bacterium, was isolated in both the river and Burlington Ditch at York Street and in the South Platte downstream from Metro.

Flow in the river during December was about one-fourth of that observed during the August-September stream survey. From December 13 to 17, 1971, water samples were collected for chemical analyses in the reach from 19th Street to 88th Avenue. Findings [Table D-9] illustrated the effects of the Metro discharge on receiving water quality. To improve water quality in this reach it has been recommended[12] that the Metro plant discharge an effluent which contains not greater than 10 mg/l each of BOD and suspended solids.

Four Great Western Sugar Company mills discharge treated wastewater directly into the South Platte River. These plants are located in or near the cities of Brighton (RM 295.7), Fort Morgan (RM 196.2), Sterling (RM 150.4), and Ovid (RM 94.8). Sampling stations were established upstream of and downstream from each of these sugar beet processing mills in order to evaluate the impact of mill waste discharges on the water quality and biota in the river.

Upstream (RM 296.1) of the Great Western Company mill at Brighton the South Platte River was polluted by waste discharges from metropolitan Denver. The stream was murky and sludge deposits blanketed portions of the bottom. Water samples from this reach were seriously contaminated with bacteria (log mean of >760,000 total coliform; 31,000 fecal coliform, and 22,000 fecal streptococci/100 ml of water). Benthic invertebrates consisted of eight kinds, with 95 percent being pollution-tolerant sludgeworms [Table G-13]. Dissolved oxygen (5.1 to 5.4 mg/l) in this reach was depressed by the residual wastes from upstream discharges.

The effluent from the Brighton wastewater treatment plant enters the river at RM 295.8. Bacterial densities (total coliform >910,000/100 ml, fecal coliform 31,000/100 ml) downstream from this discharge (RM 295.7 upstream of the Great Western mill discharge) were similar to those at RM 296.1.

Nutrients discharged by this municipal treatment plant stimulated dense growths of *Sphaerotilus* and algae [Figure 26]. The number of benthic invertebrates decreased to $71/ft^2$; of the five kinds found, 90 percent were sludgeworms. Dissolved oxygen was depressed; it ranged from 4.5 to 5.0 mg/l.

Downstream (RM 294.4) from the Great Western mill (Brighton) discharge (RM 295.7) degradation of the South Platte water quality continued. The effluent from the sugar mill was low in BOD (230 lb/day BOD) and in bacterial contamination (>110 and 1,700/100 ml fecal coliform and fecal streptococci, respectively). However, nutrient concentrations* were adequate to stimulate massive growths of slimes and algae [Figures 26 and 27].

Bacterial contamination values of the South Platte River, downstream

---

* Data, reported by the Great Western Company for October-December 1971, show phosphorus in the range of 0.05 to 0.25 mg/l and nitrogen ranging from 17.5 to 20.4 mg/l.

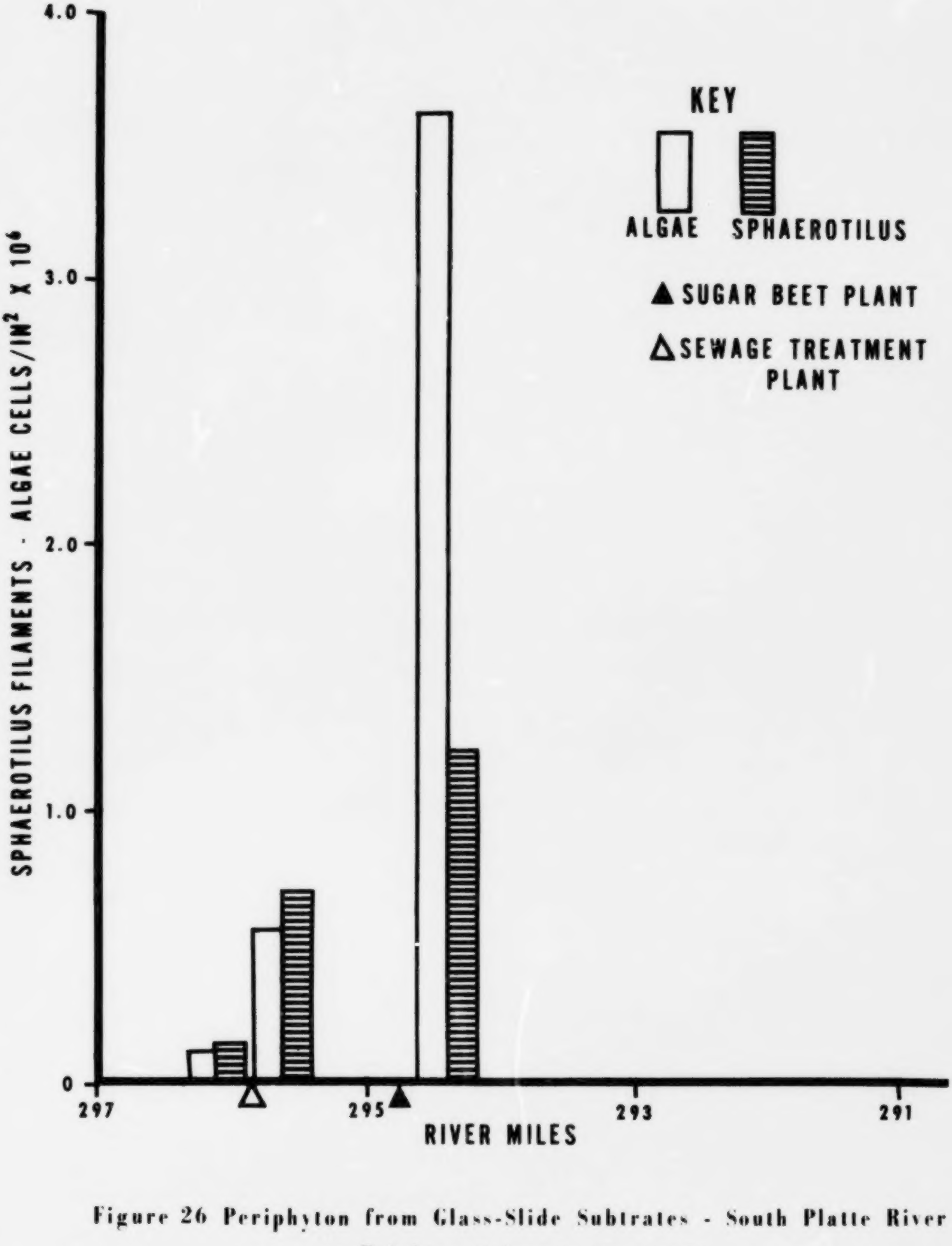


Figure 26 Periphyton from Glass-Slide Subtrates - South Platte River at Brighton, Colorado Nov. 1971

SC-B

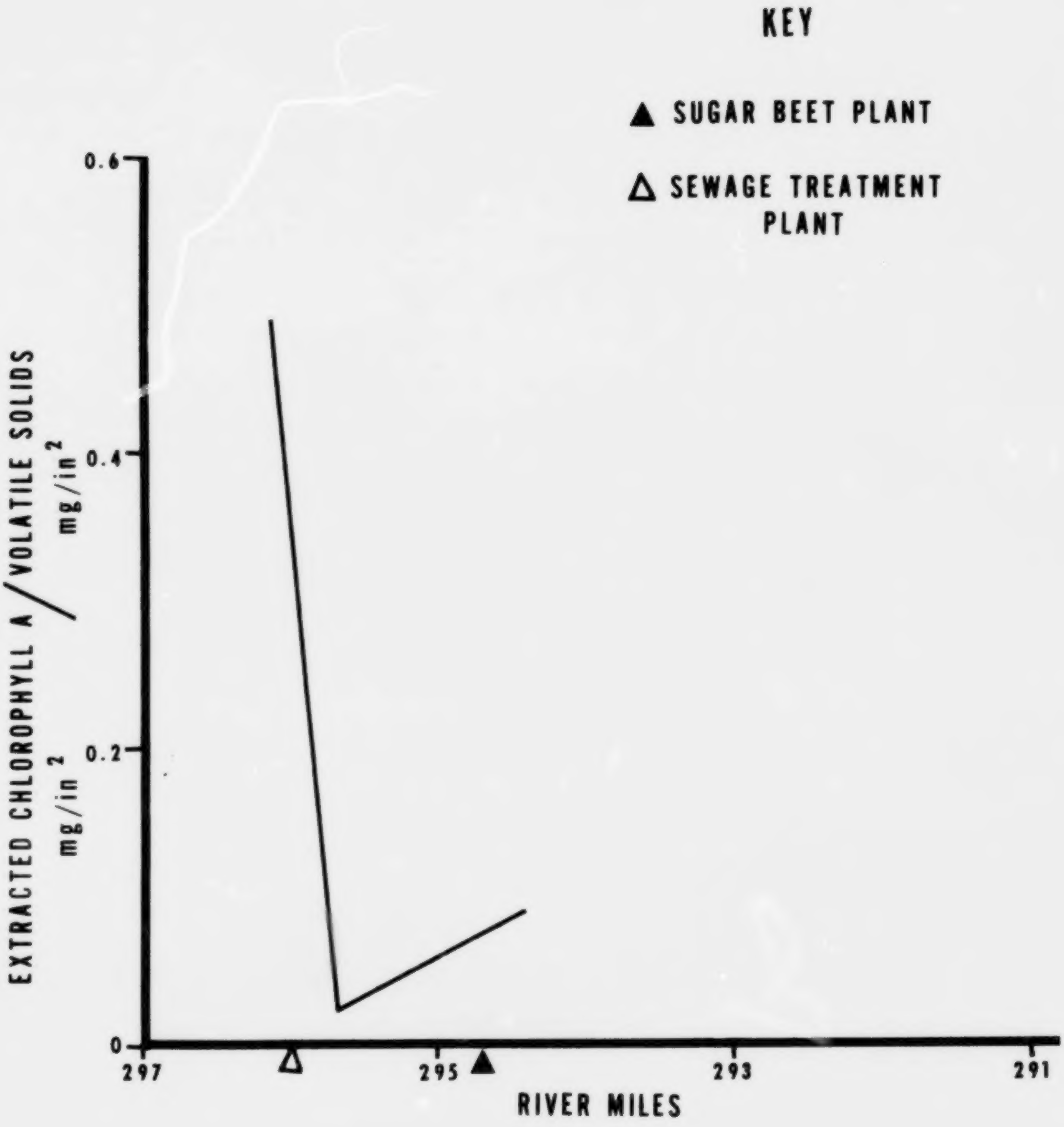


Figure 27 Extracted Chlorophyll a-Volatile Solids Ratio from Glass-Slide Substrates - South Platte River at Brighton, Colorado Nov. 1971

from all municipal and industrial waste discharges in the Brighton area, were similar to those often found in sewers; fecal coliform bacteria densities were 77,000/100 ml and fecal streptococci were 51,000/100 ml, while total coliform bacteria numbered more than one million/100 ml of water. Benthos collected from the sludge-covered river bed were dominated by sludgeworms (86 percent). The DO ranged from 4.5 to 5.3 mg/l. During the December 6 to 10, 1971 survey, flows increased from an average of 200 cfs at Henderson (RM 301.7) to an average of 322 cfs at Fort Lupton (RM 288.2).

Studies conducted both in January 1964 and January 1965 indicated that the South Platte River, upstream from the Great Western mill (Brighton), was polluted by organic waste from Denver.[4/] The river near Brighton carried over 42,000 lb of BOD (flow of approximately 100 cfs), with the Great Western mill adding about 27,000 lb. The DO upstream of this sugar beet processing mill was as low as 3.1 mg/l; downstream the DO was reduced to 1.7 mg/l. Waste loads carried by the South Platte upstream of Brighton, as determined during the 1971 survey, were of the same magnitude as in 1964 and 1965; however, with the waste load reduction at the sugar beet mill, there was only a minor increase in the waste load carried downstream.

Water quality conditions were examined (during December 6-7, and 13-15, 1971) on the South Platte River, both upstream and downstream from the Cache la Poudre River, in order to determine the effects of the discharges from the municipal waste treatment plant and the Great Western Sugar Company mill -- both in Greeley. These two sources discharged a combined BOD load of about 35,000 lb/day. Upstream (RM 250.6) of its confluence with the Cache la Poudre River, the South Platte River appeared moderately polluted by residual wastes. Bacterial densities (log mean) were greater than 140,000/100 ml total coliform, 4,300/100 ml fecal coliform, and 11,000/100 ml fecal streptococci. Downstream, at RM 246.5, the fecal coliform densities increased by a factor of about four. Dense growths of *Sphaerotilus* developed. Sludgeworms increased in numbers, replacing the pollution-sensitive insects observed upstream of the Cache la Poudre River confluence.[13/]

A comparison with studies[4/] conducted in both January of 1964 and of 1965 indicated that although there has been some restoration of quality, additional improvement is necessary. During the time of the earlier studies the Cache la Poudre was carrying each day more than 150,000 pounds BOD to the South Platte River. At that time three sugar-beet processing mills and the Monfort of Colorado packing plant were all discharging to the Cache la Poudre River. The daily residual waste carried by the South Platte River upstream of the mouth of the Cache la Poudre River was about 80,000 pounds BOD. The BOD level upstream ranged from 43 to 54 mg/l, while downstream (RM 246.6) it ranged from 73 to 99 mg/l and DO decreased to 3.0 mg/l.

In 1971, water quality improvement in the South Platte had been achieved by additional treatment at the Longmont (St. Vrain Creek Basin), Loveland and Johnstown (Big Thompson River Basin), and at the Eaton (Cache la Poudre River Basin) Great Western sugar mills, and by the closure of the Windsor mill. The BOD level upstream ranged from 7.5 to 15 mg/l, while downstream (RM 246.5) it ranged from 16 to 36 mg/l and the DO ranged from 7.6 to 9.1 mg/l [Table D-10]. However, further improvement is necessary to prevent water-quality degradation in the South Platte River.

From upstream of Fort Morgan (RM 196.6) downstream to the I-80 bridge in Nebraska (RM 81.1) the river was surveyed at selected stations (upstream and downstream from Great Western Fort Morgan, Sterling, Julesburg and Ovid sugar mill discharges) during the period November 29 to December 3, 1971. Stream flows were measured at the USGS gages located at Weldona, Balzac and Julesburg [Table D-11]. Irrigation diversions and accretions caused flow variations between these points. During the survey the flows at Kersey (RM 246.6) and at Weldona (RM 203.9) averaged 874 and 288 cfs, respectively. The decrease in flow between these two points was attributed to diversions for storage.

Water quality of the South Platte River upstream of Fort Morgan was improved over that observed at Kersey. Bacterial densities were reduced to a log mean total coliform of 500, fecal coliform of 53, and fecal streptococci of 950/100 ml. Algal and slime growths were minor [Table F-2] and the sandy stream bed was free from sludge deposits. The bottom-dwelling animals were limited to nine kinds of organisms due to the shifting sand bottom. The presence of mayflies and caddisflies indicated the absence of the severe pollution.

During the time of the survey, the Great Western sugar mill at Fort Morgan (RM 196.2/0.80) discharged approximately 2,300 lb per day of BOD. (Company data indicated that effluent loads up to 26,000 lb per day of BOD were discharged during the 1971-72 campaign). Nutrients from the mill discharge sustained slimes and algae in this river reach [Figure 28]. Although pollution did not result in serious bacterial contamination [Table E-9] or sludge accumulation, it did have an adverse affect on benthos. Bottom-dwelling invertebrates numbered 257/ft^2 and were represented by five, kinds of which sludgeworms accounted for about 83 percent.

At Sterling, upstream of the Great Western mill (RM 151.6), the bacterial densities were low (log mean densities of 150 total coliform, less than 22 fecal coliform, and 150/100 ml fecal streptococci) and excessive slime or algal growths were absent [Table F-2]. Of the six kinds of organisms collected 95 percent were pollution-tolerant sludgeworms, while intolerant forms were limited to a few caddisflies and a single type of mayfly [Table G-13]. The benthic invertebrate community indicated that this river reach was degraded. The BOD was low [Table D-11] and the DO level was adequate (10.2 to 11.5 mg/l).

The Great Western Sugar Company mill at Sterling discharged about 1,450 lb per day of BOD during the time of the survey. Bacterial densities (log mean) measured 370/100 ml fecal-coliform bacteria and more than 860,000/100 ml fecal streptococci. The low-fecal coliform densities were attributed to the toxic effect of high pH (range 8.4 to 8.6).

Downstream from the Sterling mill discharge (RM 150.0) the South Platte River was severely polluted. Massive growths of slimes and algae covered logs, rocks, and other submerged objects [Figure 29]. Fecal-coliform bacteria density was 63/100 ml (log mean), but other more tolerant forms of bacteria survived, resulting in total coliform and fecal streptococci densities of greater than 350,000 and 31,000/100 ml, respectively. Pollution was so intense at RM 150.0 that the pollution-tolerant sludgeworms were virtually eliminated (reduced from 752/ft^2 at RM 151.6 to 6/ft^2). Sections B and D of the Basic Standards were violated in this reach of the river.

60-A

60-A

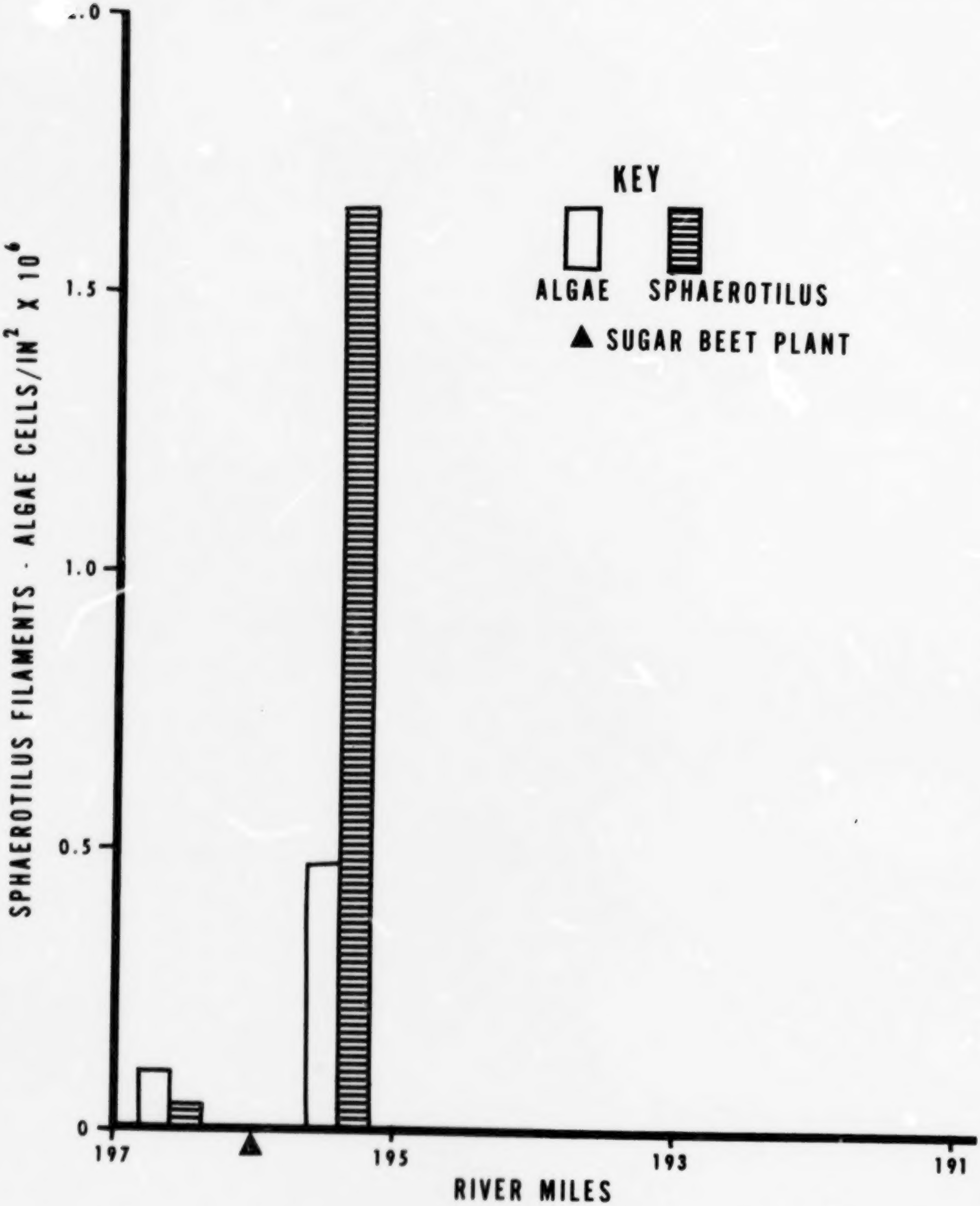


Figure 28 Periphyton from Glass-Slide Substrates - South Platte River at Fort Morgan, Colorado Nov. 1971

60-b

60-B

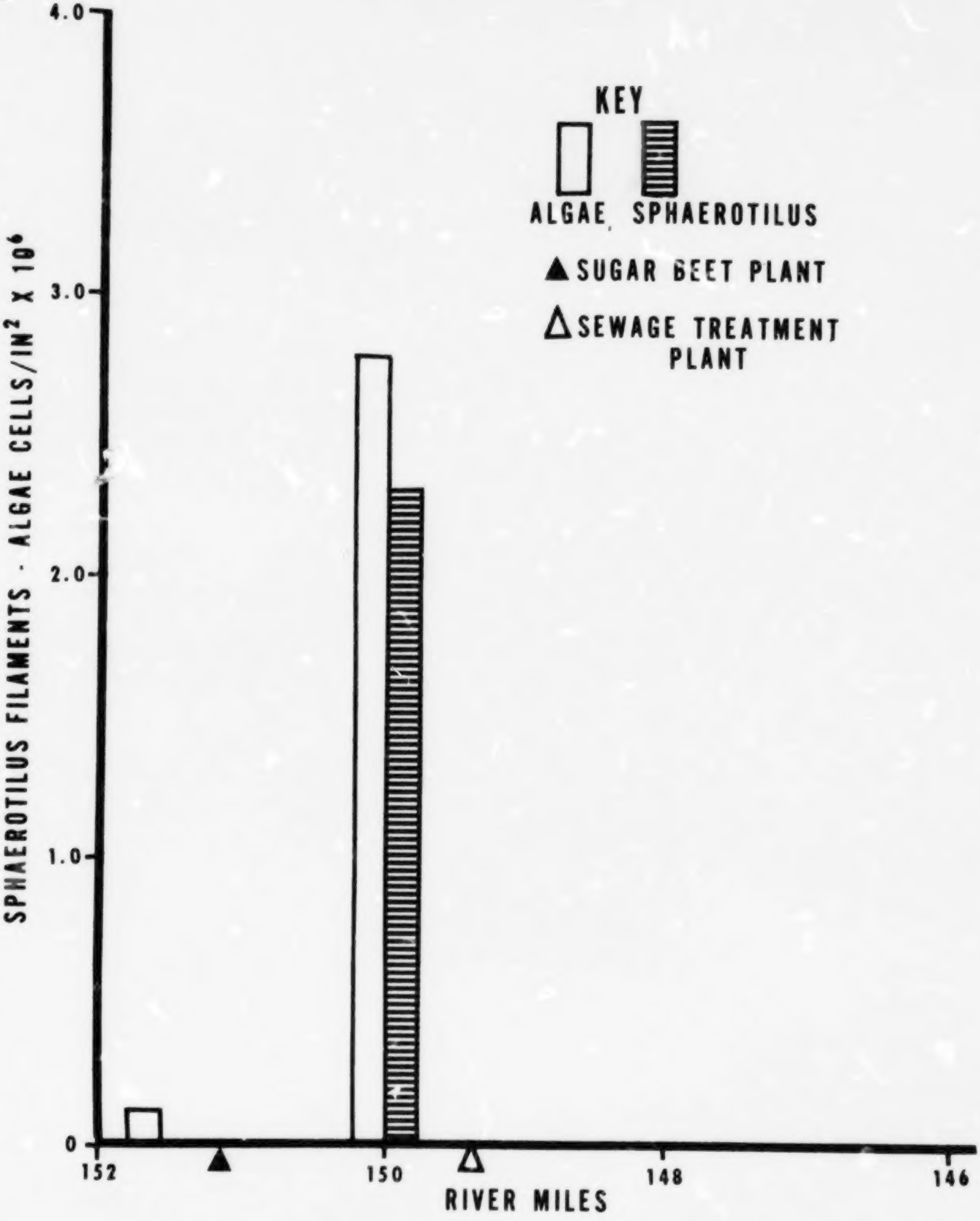


Figure 29 Periphyton from Glass-Slide Substrates - South Platte River at Sterling, Colorado Nov. 1971

Water quality was good in the South Platte River at RM 95.4 (upstream of the Great Western sugar mill at Ovid). Coliform bacteria numbered 1,900/100 ml total and 140/100 ml fecal. The BOD was 3.5 mg/l. Growths of algae and slimes were low [Table F-2]. The river water was clear and the sand bottom free from sludge deposits. Benthos were limited to eight kinds because the shifting sand was a poor habitat. However, the invertebrates included sensitive forms such as caddisflies and mayflies indicating this stream reach was free from serious pollution. (A survey, conducted by the South Platte River Basin Project during December 1963, showed fecal coliform concentrations of more than 300/100 ml and a BOD of more than 3 mg/l during similar flow conditions.)[4/]

Downstream (RM 94.0) from the Great Western sugar mill (Ovid) discharge the log mean fecal coliform densities increased by a factor of 2,000 times, and the BOD increased to 13 mg/l. This discharge stimulated algal and slime growth. Sludge deposits blanketed portions of the sandy stream bed. These deposits, composed of organic materials, provided habitat and food for the sludgeworm-dominated benthic community [Table G-13]. In this reach violations of Sections B and D of the Basic Standards were observed.

At Julesburg (RM 86.9), upstream of the municipal waste treatment plant discharge, the quality of the South Platte River, although improved, was degraded. Algal and slime growths were reduced [Figure 30]. Bacterial contamination remained high, with a log mean fecal coliform level of 93,000/100 ml and a fecal streptococci density of more than 150,000/100 ml. The water was clear. The sandy bottom supported a limited amount of benthos (seven kinds, 13 organisms/ft^2) including a few pollution-sensitive forms (i.e. caddisflies).

The Julesburg waste treatment plant discharges at RM 86.6. Flow was estimated at 0.2 mgd and the fecal coliform density (log mean) in the effluent was 160,000/100 ml, at least one order of magnitude less than the density at the Great Western mill discharge (>1.9 X 10^6/100 ml). However, the contribution from the Julesburg plant was not meeting the disinfection requirements of the State of Colorado.

The South Platte River, downstream from the Colorado-Nebraska state line (RM 81.1), was polluted. Although the water was clear, it was bacterially contaminated. It contained total and fecal coliform densities (log mean) of 610,000 and 120,000/100 ml, respectively, and these densities were 60 times greater than those allowed by the Nebraska bacterial criterion.[14/] In this reach dense algal growth bordered the stream bed. Benthos numbered about 5,900/ft^2 of which 83 percent were pollution-tolerant sludgeworms.

Studies conducted during December 1963[4/] from Fort Morgan to the Colorado-Nebraska state line were compared with the 1971 findings. During the earlier survey the sugar mills at Fort Morgan, Sterling, and Ovid daily discharged more than 93,000 pounds of BOD to the South Platte River (Fort Morgan mill, 16,000 lb/day; Sterling mill, 42,000; and Ovid mill, 35,000). Very high bacterial counts (total-and fecal-coliform) were observed downstream from these discharges. At times a complete lack of oxygen was observed. At the Colorado-Nebraska state line, total and fecal coliform bacteria densities were about 750,000 and 35,000 MPN/100 ml, respectively.

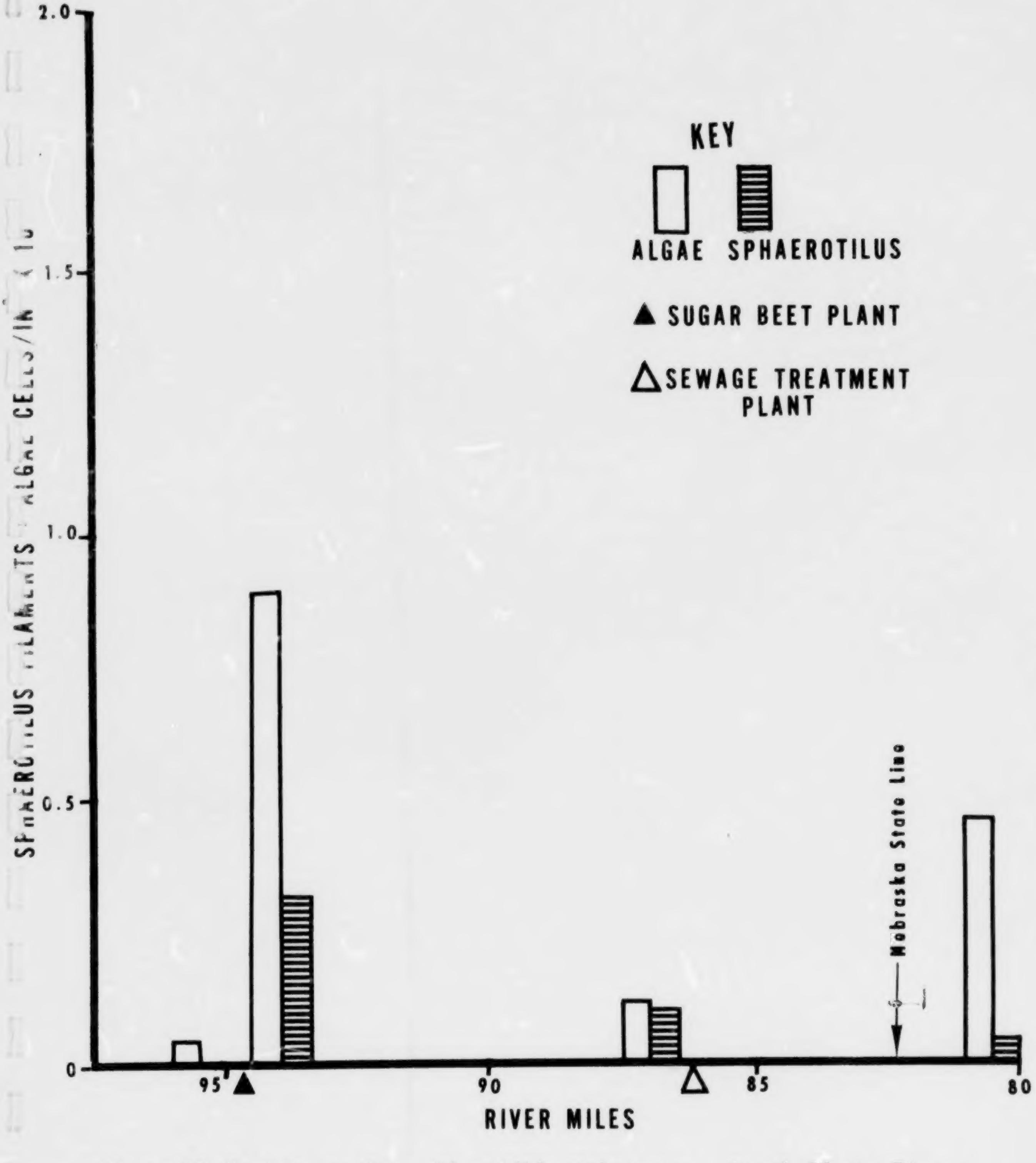


Figure 30 Periphyton from Glass-Slide Substrates - South Platte River. Colorado-Nebraska State Line Nov. 1971

In summary, the November and December 1971 survey of the South Platte River showed that water pollution control measures in operation at the Brighton Great Western mill have reduced the amount of degradation of water quality downstream. Residual wastes from the Metropolitan Denver area have continued to pollute the river. Conditions in the river upstream and downstream from the Cache la Poudre River were improved over those observed in 1964 and 1965; however, additional treatment is required in the Greeley area. Water quality conditions have improved in the reach from Fort Morgan to the Colorado-Nebraska state line by additional pollution control at the three sugar mills. However, additional measures are necessary if the water quality standards in the South Platte River are to be met.

V. WASTE SOURCE EVALUATIONS

A total of 44 industrial and 23 municipal waste sources were investigated during the period August 1, 1971 to February 5, 1972. Nine industrial sources were sugar-beet-processing mills owned by the Great Western Sugar Company. Individual municipal-waste-sources reports are contained in the report entitled *Technical Appendix on Municipal Waste-Source Evaluations, Water Quality Investigation in the South Platte River Basin, Colorado, 1971-72.* Industrial-investigation reports are contained in the report entitled *Technical Appendix on Industrial Waste-Source Evaluations, Water Quality Investigations in the South Platte River Basin, Colorado, 1971-72.* Waste treatment recommendations for municipal and industrial waste sources were based on the following factors:

1. Expected low flows in the receiving stream determined by an examination of available flow records;
2. Compliance with applicable water quality standards;
3. Installation, at industrial sources, of best practicable treatment technology currently available;
4. Pretreatment of industrial wastes, where applicable, prior to discharge to municipal treatment plant, to levels comparable with that expected of untreated domestic sewage (250 mg/l biochemical oxygen demand and suspended solids);
5. Effluent limits for municipal discharges consistent with those established for industries using best practicable treatment technology.

Of the 44 industries visited, twenty-three were selected for in-plant sampling to determine the waste loads discharged and the adequacy of present pollution control practices. [A summary of the analytical results, and abatement needs for the industrial waste sources, are contained in Tables I-1 through I-5.] The following industries require additional pollution abatement measures:

Adolph Coors Company -- Golden, Colorado
Great Western Sugar Company plants at Greeley, Ovid, Johnstown, Longmont, Fort Morgan and Sterling
Continental Oil Company -- Commerce City, Colorado
Refinery Corporation -- Commerce City, Colorado
Weld County By-Products Company -- Greeley, Colorado
Loveland Packing Company -- Loveland, Colorado

Pollution abatement needs were apparent at the following industries which were not sampled:

Burlington Northern Railroad, Inc. -- Denver, Colorado
Floyd Haag Sand and Gravel Company -- Loveland, Colorado

The twenty-three municipal waste treatment plants that were investigated discharged more than 95 percent of the municipal wastes generated in the South Platte River Basin. The following plants were not meeting the 80 percent minimum BOD removal requirement of the State of Colorado:

Baker Water and Sanitary District
Boulder Pearl Street
Boulder 75th Street
Brighton
Englewood[*]
Fort Collins Plant #1
Fort Morgan
Greeley
Julesburg
Longmont
Loveland
Littleton
Metropolitan Denver Sewage Disposal District #1 Plant (Metro)

---

[*] The Englewood plant was being expanded at the time of the evaluation. Operational procedures had been modified to accomodate the construction activities.

South Adams Water and Sanitation District
South Lakewood Sanitation District
Sterling
Wheatridge

[A summary of the analytical results and abatement needs for the municipal plants is contained in Tables I-6 through I-10.] A brief discussion of the waste sources discharging into selected reaches of the South Platte River and its tributaries follows.

A. SOUTH PLATTE RIVER AND TRIBUTARIES-WATERTON TO PLATTEVILLE

Within this portion of the basin the discharges from municipal waste treatment plants and Adolph Coors Brewery were the major sources of pollution. The 11 municipal plants[*] evaluated in this portion of the basin discharged more than 140 mgd of which approximately 115 mgd (82 percent) were discharged by Metro.[12/] The Metro plant also discharged about 75 percent of the BOD load. Studies[4/] in 1964-65 indicated that the BOD load discharged by municipal plants in the study reach was about 135,000 lb/day. During the 1971-72 surveys, an estimated 55,000 lb/day (including the wastes from Coors) originated from waste sources in this reach.

Industrial discharges in the reach totaled approximately 45 mgd in 1971 of which 75 percent was cooling water discharged by the plants of the Public Service Company of Colorado. During an in-plant survey in February the Coors brewery (Golden) was discharging about 7,900 lb per day of BOD to Clear Creek. The brewery discharge constitutes the largest single waste source to this stream. South Platte Project studies,[2/]

---

[*] The Littleton, Englewood, South Lakewood Sanitation District, Metro, South Adams Water and Sanitation District, and Brighton and Ft. Lupton plants discharge directly to the South Platte River. The Wheatridge Sanitation District, Clear Creek Valley Sanitation District, Arvada, and Baker Water and Sanitation District plants discharge to Clear Creek.

conducted in 1964-65, showed that the brewery discharged less than 700 pounds/day of BOD (2.7 mgd at 30 mg/l). Coors was reported to have been operating its plant at 96 percent efficiency. An in-plant survey (see Technical Appendix on Industrial Waste Source Evaluations) revealed that the Company was providing about 81 percent removal of BOD. However, the waste discharge from this plant has increased by a factor of ten since 1964.

Downstream from Golden four municipal plants discharged about 6.5 mgd containing 3,600 lb BOD/day to Clear Creek or one of its tributaries. Studies[16/] (in 1964) indicated that approximately 22,000 lb per day of BOD were being discharged to the stream from nine plants, including Coors. With the construction of the Metro plant and the diversion of all or a portion of the flow from some of these plants to Metro, there has been a substantial BOD reduction. Total loads now discharged daily by the combination of the Adolph Coors Brewery and the four municipal plants are about 11,000-12,000 pounds. The four municipal plants treat less than five percent of the total municipal waste flow in the Denver Metropolitan area. Three of these plants -- Wheatridge Sanitation District, Arvada, and Baker Water & Sanitation District -- are connected to the Metro system. The latter two divert a major portion of their flows to Metro. It appears feasible for the total wastes of all four plants to be treated by Metro.

The South Adams Water and Sanitation district plant located downstream from Metro and Clear Creek was not providing adequate treatment during the survey. At Brighton (RM 295.8) inadequate treatment was provided. An expansion of the facilities was underway. The Great Western Sugar Company mill (Brighton) was discharging an effluent containing

230 lb per day of BOD. This mill exemplified the effective pollution control that is achievable in a sugar beet processing mill. The Ft. Lupton Wastewater Treatment Plant (RM 287.6) was providing adequate treatment and disinfection.

B. ST. VRAIN CREEK BASIN

The two waste treatment plants at Boulder constitute the major discharges to Boulder Creek, a tributary of St. Vrain Creek. In-plant evaluations carried out during 1971 (Technical Appendix on Municipal Waste-Source Evaluations) indicated that these two plants were not providing adequate treatment. However, the planned plant expansion and improved methods of operation should alleviate treatment problems.

The major discharges to St. Vrain Creek were effluents from the Longmont Wastewater Treatment Plant and, during the sugar beet campaign, the Longmont Great Western mill. An in-plant evaluation of the Longmont Wastewater Treatment Plant revealed that adequate treatment (80 percent BOD removal) was not provided. The combined effect of discharges from both this plant and the Great Western mill was detrimental to the receiving waters. The Longmont wastewater plant should be discharging an effluent containing no more than 25 mg/l each of BOD and suspended solids; the Great Western mill should be discharging no greater than one-half lb each of BOD and suspended solids per ton of beets sliced, not to exceed 1,650 lb of each per day, whichever is less. The latter is attainable in the sugar-beet processing industry using available waste treatment technology.

C. BIG THOMPSON RIVER BASIN

Major waste sources in this basin were the Loveland waste treatment plant and the Great Western mills at Loveland and Johnstown. Treatment at the municipal plant was not adequate. A 3-day, in-plant survey revealed that the BOD removal efficiency ranged from 59-71 percent.

In 1964 the daily waste load from the Loveland Great Western mill was about 50,000 lb BOD.[4,10] During a three-day survey, in December 1971, the waste loads amounted to less than 1,000 lb per day. This Great Western plant discharged 0.33 lb BOD and 2.66 lb suspended solids per ton beets sliced during the 1971-72 campaign.[17] Solids concentrations were higher than levels attainable through present treatment technology for the sugar-beet processing industry, i.e., one-half lb per ton of beets sliced.

The major discharge to the Little Thompson River was from the Great Western sugar recovery and monosodium glutamate factory, located near Johnstown. This plant operates on a continuous basis. In December 1971, a 3-day survey of the effluent revealed that the plant discharged each day more than 7,000 lb BOD. The effluent had a strong sulfide odor and discolored the receiving water. Further treatment of this effluent is required.

Three small municipal plants (Berthoud, Johnstown, and Milliken) discharged to the Little Thompson River. These plants were reported* to have adequate treatment.

---

* This information was provided by officials of the Colorado State Department of Health.

D. CACHE LA POUDRE RIVER BASIN

The major discharges in this basin were the two municipal waste treatment plants in Fort Collins (Plants No. 1 and 2), the Greeley waste treatment plant, and the Great Western mills (Eaton and Greeley). Other potential industrial sources were the Farr Farms and the Monfort of Colorado feedlots and packing plant (all in the Greeley area).

The two municipal plants at Fort Collins discharged about 3,200 lb of BOD and 4,500 lb of suspended solids daily to the Cache la Poudre River in January 1972. Treatment efficiency at Plant No. 1 was less than 80 percent during a 3-day plant evaluation.

The Greeley waste treatment plant and the Greeley Great Western mill discharged 35,000 lb of BOD each day to the Cache la Poudre during a survey in December 1971.[13/] Company data for the 1971-72 beet campaign showed that the BOD load from the mill varied from 9,100 lb per day, in October, to more than 37,000 in January. The Greeley waste treatment plant was grossly overloaded by the Monfort packing plant wastes. A new plant is proposed to handle the Monfort wastes and activated sludge from the existing plant. This will alleviate the overloaded condition.

The Farr Farms and Monfort feedlots have installed holding ponds with the effluent either employed for irrigation or diverted to evaporation lagoons. No contamination from animal wastes was apparent during the 1971 stream surveys (September and November-December).

Since the 1964-65 studies the Great Western mill at Eaton has installed pollution control facilities. Waste loads discharged by this plant were less than one-half lb each of BOD and suspended solids per ton of beets processed; these figures are considered to be the upper limit for waste loads discharged from sugar-beet processing mills. The Eaton waste treatment plant discharged an effluent containing 72 mg/l BOD. The removal efficiency was not determined, but visual observations indicated a poor quality effluent. Disinfection was inadequate.

E. SOUTH PLATTE RIVER - FORT MORGAN TO THE STATE LINE

Three sugar-beet processing mills and four municipal plants were evaluated in this reach. (Findings of the sugar beet mill evaluations are summarized in Tables I-3 through I-5.) Treatment at all four municipal plants was less than the 80 percent BOD removal level required by the State. Moreover, the Fort Morgan and Brush plants provided no disinfection during the survey and disinfection practices at Sterling and Julesburg were inadequate.

The three mills were exceeding the one-half-pound BOD per ton sliced beets achievable by best practicable treatment practices for the sugar beet industry. Additional or improved treatment is necessary at these mills. The mill located at Ovid was recently the subject of a 180-day notice hearing called by EPA, Region VIII, for the purpose of discussing violations of interstate stream standards.

REFERENCES

1. *Report of South Platte Basin Water Pollution Investigation.* Federal Security Agency, U. S. Public Health Service, Environmental Health Center, Cincinnati, Ohio and Missouri River Basin Office, Water Pollution Control Division, Kansas City, Missouri, (1950).

2. *Conference in the Matter of Pollution of the South Platte River Basin in the State of Colorado, Proceedings, First Session.* Denver, Colorado. U. S. Department of Health, Education, and Welfare, Federal Water Pollution Control Administration, South Platte River Basin Project. October 1963.

3. *Conference in the Matter of Pollution of the South Platte River Basin in the State of Colorado, Proceedings, Second Session.* Denver Colorado, U. S. Department of Health, Education, and Welfare, Federal Water Pollution Control Administration. (3 vol) April 27, 1966.

4. *Report to the Second Session of the Conference in the Matter of Pollution of the South Platte River Basin.* U. S. Department of Health, Education, and Welfare. Federal Water Pollution Control Administration, South Platte River Basin Project. Denver, Colorado. April 1966.

5. *Conference in the Matter of the Pollution of the South Platte River Basin in the State of Colorado.* U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, Denver, Colorado. November 10, 1966.

6. *A Study of Industrial Waste Pollution in the South Platte River Basin.* U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, PR-6C. Denver, Colorado. December 1966.

7. *Effects of Pollution on Aquatic Life Resources of the South Platte River Basin in Colorado.* U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, Denver, Colorado, and Technical Advisory and Investigation Branch, Cincinnati, Ohio. Report PR-11 XVII + 149 pp. December 1967.

8. *Water Pollution Survey of the Great Western Sugar Company and the Kuner-Empson Canning Company of Colorado*, Colorado State Final Report. November 24, 1969 to March 11, 1970.

9. *Water Quality, Middle Basin Tributary Streams, South Platte River Basin, Summer 1965.* U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project. PR-8. Denver, Colorado. December 1967.

10. *The Beet Sugar Industry--The Water Pollution Problem and Status of Waste Abatement and Treatment.* U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project. Denver, Colorado. Report PR-8, XII + 142 pp. June 1967.

11. *Water Quality Investigations in the South Platte River Basin 1971.* Environmental Protection Agency, Office of Enforcement, Division of Field Investigations-Denver Center, Denver, Colorado. June 1971.

12. *Report on Effects of Waste Discharges on Water Quality of South Platte River - Denver Metropolitan area.* Environmental Protection Agency, Office of Enforcement, National Field Investigations Center-Denver, and Region VIII. Denver, Colorado. February 1972.

13. *Report on Effects of Waste Discharges on Water Quality of the Cache la Poudre and South Platte Rivers - Greeley Area.* Environmental Protection Agency, Office of Enforcement, National Field Investigations Center-Denver, and Region VIII. Denver, Colorado. February 1972.

14. *Report on Investigation of the Effects of the Waste Discharges from the Great Western Sugar Mill at Ovid, Colorado on Water Quality Conditions in the South Platte River.* Environmental Protection Agency, Office of Enforcement, Division of Field Investigations-Denver Center, Denver, Colorado. December 1971.

15. *Criteria Used in the Review of Waste Water Treatment Facilities.* Colorado Department of Health, Water Pollution Control Division. Denver, Colorado. September 1969.

16. *Municipal Waste Report Metropolitan Denver Area, South Platte River Basin,* PR-3, U. S. Department of Health, Education, and Welfare, Division of Water Supply and Pollution Control, South Platte River Basin Project. Denver, Colorado. December 1965.

17. *R. W. Brenton Memorandum--Condenser Water Survey 1971-72 Campaign,* Great Western Sugar Company. Denver, Colorado. March 1972.

APPENDIX A

WATER QUALITY STANDARDS FOR COLORADO AND NEBRASKA

A-1-a

March 4, 1971

Honorable John A. Love
Governor of Colorado
Denver, Colorado 80203

Dear Governor Love:

I am pleased to inform you that I am now approving Colorado's water quality standards in their entirety, based upon my determination that they are consistent with the protection of the public health and welfare, the enhancement of the quality of the water and the purposes of the Federal Water Pollution Control Act as provided by Section 10(c)(3) of that Act. These consist of the standards approved by the Secretary of the Interior on October 21, 1968 and October 9, 1969, and the additions and revisions adopted by the Water Pollution Control Commission on June 10, July 14, August 11, October 13 and November 10, 1970, and submitted to the Water Quality Office, Environmental Protection Agency, on December 4, 1970. The standards as approved are those applicable under the Federal Water Pollution Control Act to the interstate waters of Colorado.

We are all aware that water quality criteria and stream classifications are subject to change as we acquire new knowledge and understanding of the factors that affect water quality and as existing conditions are improved. The Water Quality Office will continue to maintain close contact with Colorado's Water Pollution Control Commission regarding the important matter of water quality standards.

Signed by:

William D. Ruckelshaus

This letter has been retyped for
microfilming purposes only and
corrections made regarding
approval dates.

TERMS AND DEFINITIONS
AS PRESENTED BY
COLORADO WATER POLLUTION CONTROL COMMISSION

1.	BIOCHEMICAL OXYGEN DEMAND	- A measure of the amount of oxygen necessary to satisfy the biochemical oxidation requirements of pollution in a sample that is maintained at a temperature of 20° Centigrade for a period of five days.
2.	BIOCIDE	- A toxic, chemical substance or mixture intended to abate or destroy noxious forms of life, such as vermin, insects, viruses and fungi harmful in agriculture, fisheries, and forestry.
3.	CLASSIFICATION	- The application of a standard or standards to a segment or segments of the waters of the State.
4.	CONDUCTIVITY	- A measure of the ability of water to conduct an electric current, which may be used for approximating the salinity in water.
5.	CONTROLLABLE SOURCES	- A source of waste discharge that can be controlled by physical means.
6.	DISINFECTION	- A method of reducing the organisms pathogenic to man.
7.	DISSOLVED OXYGEN	- A measure of the amount of free oxygen (oxygen which is not chemically combined with other substances) available in water to oxidize oxygen demanding materials.
8.	MF	- Refers to the membrane filter technique of water analysis. This technique involves the passing of a certain volume of water through a cellulose ester filter which is then impregnated with a food product for the bacteria that are retained on the surface of the filter.
9.	MPN	- An abbreviation of "Most Probable Number" - a test of bacterial density derived from multiple tube fermentation techniques. It is expressed as a number of organisms per hundred milliliters. It is a number most likely to occur, in statistical theory, under the given circumstances or conditions of the test.

10. MILLIEQUIVALENT PER LITER - A unit for expressing the concentration of chemical constituents in terms of interreacting values of electrically charged particles or ions in solution. One milliequivalent per liter of a positively charged ion will react with one milliequivalent per liter of a negatively charged ion.

11. MILLIGRAMS PER LITER - Also referred to as "parts per million". This is a unit for expressing the concentration of any substance by weight, usually as grams of substance per million grams of solution. Since a liter of water weighs one kilogram, one milligram per liter is equivalent to one part per million.

12. MILLILITER - One-thousandth of a liter. One liter is equal to 1.06 quarts.

13. NATIONAL BUREAU OF STANDARDS HANDBOOK 69, LATEST EDITION - A reference book published by the U. S. Department of Commerce, National Bureau of Standards. It contains recommendations as to the maximum permissible concentrations of radio nuclides in the human body, air, and water.

14. pH - The pH value indicates the relative intensity of acidity or alkalinity of water, with the neutral point at pH 7.0. Values lower than 7.0 indicate the presence of acids; above 7.0, the presence of alkalies.

15. SECONDARY TREATMENT - A method of treatment in which a minimum of 80% of the biochemical oxygen consuming material is removed.

16. SODIUM ADSORPTION RATIO - An index of hazard to physical condition of soil due to sodium in irrigation water.

17. STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTE WATER, LATEST EDITION - A publication prepared jointly by the American Public Health Association, American Water Works Association, and the Water Pollution Control Federation, accepted by Federal, State, and local authorities in the field of water pollution control as the authority for analytical procedures to be utilized in the examination or analysis of waters and waste waters.

18. STANDARDS - An official limiting value used to determine the quality of water for a classified use as established by the Water Pollution Control Commission.

19. TURBIDITY - A measure of the clarity and the light penetration of water as affected by suspended and colloidal matter.

20. EPILIMNION - In a thermally stratified lake, the layer of water that extends from the surface to the thermocline. (adopted November 10, 1970)

21. EUTROPHICATION - The process of a lake becoming rich in dissolved nutrients, thereby enhancing the growth of aquatic plants leading to possible seasonal oxygen deficiencies and accelerating the rate of lake aging. (adopted June 10, 1970)

22. HYPOLIMNION - The region below thermal stratification in a lake or reservoir. (adopted August 11, 1970)

23. NATURAL CAUSES - (as applied to temperature fluctuation standards) - Temperature fluctuations due to effluents from domestic sewage treatment plants and identifiable irrigation return flows shall be considered as originating from natural causes. (adopted August 11, 1970)

24. THERMOCLINE - In thermally stratified lakes, the layer below the epilimnion. It is the stratum in which there is a rapid rate of decrease in temperature with depth; a minimum of one degree Centigrade per meter in depth. (adopted November 10, 1970)

WATER QUALITY STANDARDS FOR COLORADO

The Second Session of the Forty-Fifth General Assembly of the State of Colorado passed Water Pollution Control Legislation for the State of Colorado as set out in Chapter 66, Article 28, C.R.S. 1963 (1967 Perm. Cum. Supp.). In adopting this legislation, the following legislative declaration was made, which also was adopted on July 14, 1970 by the Colorado Water Pollution Commission as its policy statement on nondegradation:

> "Whereas the pollution of the waters of this state constitutes a menace to public health and welfare, creates public nuisances, is harmful to wildlife, fish and other aquatic life, and impairs domestic, agricultural, industrial, recreational, and other beneficial uses of water; and whereas the problem of water pollution of this state is closely related to the problem of water pollution in adjoining states; and whereas it is the public policy of this state to conserve the waters of the state and to protect, maintain, and improve the quality thereof for public water supplies, for the propagation of wildlife, fish and other aquatic life, and for domestic, agricultural, industrial, recreational, and other beneficial uses, and to provide that no wastes be discharged into any waters of the state without first being given the degree of treatment necessary to protect the beneficial uses of such water, it is hereby declared that the prevention, abatement, and control of the pollution of the waters of this state are affected with a public interest, and the provisions of this act are enacted in the exercise of the police powers of this state for the purpose of protecting the health, peace, and safely, and general welfare of the people of this state." Relevantly, the Commission will keep the Federal Government, from time to time, advised and informed with the information required for the discharge of its responsibilities under the Federal Water Pollution Control Act, as amended.

These standards are the foundation for the classification of the waters of the State of Colorado, as defined in the Water Pollution Control Act of 1966, as amended. (adopted June 10, 1970)*

Standards are subject to revision as technical data, surveillance programs, and technological advances make such revisions desirable.

---

* Underscored material represents changes and/or additions to the original (May 1968) Colorado Water Quality Standards.

For the purposes of enforcement of these standards, sampling will be done at a point where these standards can be evaluated.

For purposes of enforcement of water classification standards, sampling of the waters will be done at any point, except for areas immediately adjacent to outfalls and except as may be noted in the text of the standards. In such areas, cognizance will be given to the opportunity for admixture of waste effluents with receiving water.

Tests or analytical procedures to determine compliance with standards will, insofar as practicable and applicable, be made in accordance with the methods given in the latest edition of "Standard Methods For The Examination of Water And Waste Water" published by the American Public Health Association, or in accordance with tests or analytical procedures that have been found to be equal or more applicable and satisfactory and accepted and approved by the Commission.

In areas where a body of water is classified for more than one use, the standards applicable to each use shall apply and in case of a conflict, the more restrictive standards shall prevail in each instance.

Where and when additional waters become available, hearings will be held on the possible classification or reclassification of such waters for further enhancement. The quality of water will be maintained as high as possible and in no case shall stream standards be violated.

It is expected that the present uses of the waters of Colorado will continue but if other uses develop, streams may be classified or reclassified after public hearings.

Waters of the state, the quality of which exceeds the limits set in these standards, will be maintained at existing quality unless and until it can be demonstrated to the State that a change in quality is justified to provide necessary economic or social development. In that case, the best practicable degree of waste treatment to protect the current classification of such waters will be required. The appropriate Federal authority will be provided with information, from time to time, required to discharge his responsibilities under the Federal Water Pollution Control Act, as amended. (adopted October 13, 1970)

I. BASIC STANDARDS APPLICABLE TO ALL WATERS OF THE STATE (adopted June 10, 1970)

A. All wastes capable of treatment or control prior to discharge into any waters of the state, shall receive secondary treatment with disinfection or its industrial waste equivalent, as determined by the State Water Pollution Control Commission. Lesser degrees of treatment or control may be permitted only where it can be demonstrated that the standards applicable to the classified use of the water can be attained. Greater degrees of treatment or control will be required where it can be demonstrated that it is necessary to comply with the standards applicable to the classified use of the water.

B. Free from substances attributable to municipal, domestic, or industrial wastes, or other controllable sources that will either settle to form unsightly, putrescent, or odorous bottom deposits, or will interfere with the classified use of the water.

C. Free from unsightly floating debris, oil, grease, scum, and other floating material attributable to municipal, domestic, or industrial wastes, or other controllable sources.

D. Free from materials attributable to municipal, domestic, or industrial wastes or other controllable sources that will produce objectionable odor, color, taste, or turbidity in the water, or objectionable aquatic life which may result in eutrophication or other conditions that interfere with the classified use of the water. (adopted June 10, 1970)

E. Free from high temperatures, biocides, toxic, or other deleterious substandes attributable to municipal, domestic, or industrial wastes, or other controllable sources in levels, concentrations, or combinations sufficient to be harmful to human or animal life.

F. Radioactive materials attributable to municipal, industrial or other controllable sources will be minimum concentrations that are physically and economically feasible to achieve. In no case shall such materials in the stream exceed the limits established in the current edition of the U.S. Public Health Service Drinking Water Standards or the limits approved by the Federal Radiation Council, or, in the absence of any limits specified by the U.S. Public Health Service or the Federal Radiation Council, 1/30 of the 168-hour-week values for other radioactive substances specified in the National Bureau of Standards Handbook 69.

II. ADDITIONAL WATER QUALITY STANDARDS FOR BODIES OF WATER THAT HAVE BEEN CLASSIFIED FOR ANY OF THE FOLLOWING USES:

CLASS A.

1. The following standards shall apply to water withdrawn for treatment as a potable supply.

   a. Bacteria: Wastes or substances from controllable sources shall not be discharged into these waters in amounts which will cause the number of organisms of the fecal coliform group, as determined by either multiple tube fermentation or membrane filter technique to exceed a log mean of 1,000 per 100 milliliters or exceed 2,000 per 100 milliliters in more than 10% of the samples collected in any 30 day period.

   b. Dissolved Oxygen: Dissolved oxygen shall not be less than 4 milligrams per liter.

   c. pH: The pH shall be maintained between 6.0 and 9.0.

   d. Taste and Odor: Free from materials attributable to municipal, domestic, and industrial wastes, or other controllable sources that will produce taste or odor in the water.

   e. Dissolved Solids: Total dissolved solids, annual volume weighted average, should be less than 500 milligrams per liter.

   f. Selected Chemical Constituents: The following substances shall not be present in such amounts as to exceed the specified concentrations in a potable water supply according to the mandatory requirements of the latest edition of the U. S. Public Health Service Drinking Water Standards:

Substances	Concentration - mg/l
Arsenic	0.05
Barium	1.00
Cadmium	0.01
Chromium (Hexavalent)	0.05
Cyanide	0.20
Lead	0.05
Selenium	0.01
Silver	0.05

CLASS B.

1. The following standards shall apply to waters classified for fish and wildlife (Cold Water Fishery):

    a. Bacteria: Wastes or substances from controllable sources shall not be discharged into these waters in amounts which will cause the number of organisms of the fecal coliform group, as determined by either multiple tube fermentation or membrane filter techniques, to exceed a log mean of 1,000 per 100 milliliters or exceed 2,000 per 100 milliliters in more than 10% of the samples collected in any 30 day period.

    b. Dissolved Oxygen: In cold water fisheries, the dissolved oxygen content shall in no case go below 6 milligrams per liter.

    c. pH: pH shall be maintained between 6.5 and 8.5. No controllable pH change will be permitted which will interfere with fish and aquatic life.

    d. Turbidity: No turbidity shall exist in concentrations that will impair natural and developed fisheries.

    *e. Temperature: In cold water fisheries the temperatures shall not exceed 70°F. No controllable temperature change will be permitted which will interfere with the spawning and other aspects of fish life. (adopted October 13, 1970)

    f. Toxic Material: Free from biocides, toxic, or other deleterious substances attributable to municipal, domestic, or industrial wastes, or other controllable sources in levels, concentrations, or combinations sufficient to be harmful to aquatic life.

    g. Other Material: Free from materials attributable to municipal, domestic, or industrial wastes, or other controllable sources that will produce off-flavor in the flesh of fish.

2. The following standards shall apply to waters classified for fish and wildlife (Warm Water Fishery):

    a. Bacteria: Wastes or substances from controllable sources shall not be discharged into these waters in amounts which will cause the number of organisms of the fecal coliform group, as determined by either multiple tube fermentation or membrane filter techniques to exceed a log mean of 1,000 per 100 milliliters or exceed 2,000 per 100 milliliters in more than 10% of the samples collected in any 30 day period. (adopted June 10, 1970)

b. Dissolved Oxygen: In warm water fisheries, dissolved oxygen content shall in no case go below 5 milligrams per liter.

c. pH: pH shall be maintained between 6.5 and 8.5. No controllable pH change will be permitted which will interfere with fish and aquatic life.

d. Turbidity: No turbidity shall exist in concentrations that will impair natural and developed fisheries.

*e. Temperature: In warm water fisheries the temperatures shall not exceed 90°F. No controllable temperature change will be permitted which will interfere with spawning and other aspects of fish life. *Note: See additional temperature criteria.... (adopted Oct. 13, 1970)

f. Toxic Material: Free from biocides, toxic, or other deleterious substances attributable to municipal, domestic, or industrial wastes, or other controllable sources in levels, concentrations, or combinations sufficient to be harmful to aquatic life.

g. Other Material: Free from materials attributable to municipal, domestic, or industrial wastes, or other controllable sources that will produce off-flavor in the flesh of fish.

*Note: Limits on temperature change in fisheries have not been established due to lack of historical temperature data and lack of conclusive temperature change criteria for the aquatic biota of waters of the state. These factual data are being collected, however, to serve as a basis for setting limits. In the meantime, the following tentative criteria will be used as administrative policy:

In cold water fisheries an abrupt change in temperature must be avoided and the normal pattern of diurnal and seasonal fluctuations must be preserved. The maximum allowable temperature increase due to waste discharges in streams and in the epilimnion of lakes shall be 2°F. No warming waste discharge shall be permitted to the hypolimnion of lakes.

In warm water fisheries an abrupt change in temperature must be avoided and the normal pattern of diurnal and seasonal changes must be preserved. The maximum allowable temperature increase due to waste discharges in streams will be 5°F; in the epilimnion of lakes the maximum increase will be 3°F. No warming waste discharge shall be permitted in the hypolimnion of lakes.

In temperature measurement, allowance shall be made for a mixing zone. Provisions shall be made for adequate mixing and no thermal barrier to migration and free movement of aquatic biota shall be permitted in any water of the state. (adopted October 13, 1970)

3. The following standards shall apply to recreational waters classified for body contact sports such as, but not limited to, swimming and water skiing:

    a. Bacteria: Total coliform bacteria shall not exceed 1,000 per 100 milliliters as a monthly average (either MPN or MF count); nor exceed this number in more than 20% of the samples examined during any month; nor exceed 2,400 per 100 milliliters in a single sample. In addition, the fecal coliform count shall not exceed 100 per 100 milliliters, and the fecal streptococcus count shall not exceed 20 per 100 milliliters, both of these limits to be an average of five (5) consecutive samples within a month.

    b. pH: pH shall be maintained between 6.5 and 8.5.

CLASS C.

1. The following standards shall apply to waters classified for industrial uses:

    a. Dissolved Oxygen: Dissolved oxygen content shall not go below 3 milligrams per liter.

    b. pH: pH shall be maintained between 5.0 and 9.0.

    c. Turbidity: No turbidity shall exist in concentrations that will interfere with established levels of treatment.

    d. Temperature: The temperature shall not exceed 90°F.

CLASS D.

1. The following standards shall apply to waters classified for irrigation:

    a. Total Dissolved Solids (Salt) Concentrations: A time-weighted monthly mean at a monitoring station which exceeds the time-weighted monthly mean for a base period established by the Commission by more than two standard deviations shall be subject to review by the Commission.

    b. Sodium Adsorption Ratio: A time-weighted monthly mean at a monitoring station which exceeds the time-weighted monthly mean for a base period established by the Commission by more than two standard deviations shall be subject to review by the Commission.

c. Toxic Material: Free from biocides, toxic, or other deleterious substances attributable to municipal, domestic, industrial wastes, or other controllable sources in concentrations or combinations which are harmful to crop life.

2. The following standards shall apply to waters classified for livestock watering:

   a. Soluble Salts: The soluble salts shall not exceed 3,000 milligrams per liter.

Table A-1 --Stream Classifications, South Platte River Basin, Colorado

Stream Reach	Quality Class Effective September, 1971
Middle Fork & Main Stem of South Platte, including Montgomery, Eleven Mile Canyon & Lake George Reservoirs, from source above Fairplay to 1,000 feet below Englewood Union Avenue Water Treatment Plant Intake	A, B_1, C, D_1
Lake Chessman Reservoir from inlet to outlet	A
Main Stem of South Platte River from 1,000 feet below Englewood Union Avenue Water Treatment Plant Intake to Exposition Avenue, Denver	B_1, C, D_1
Main Stem of South Platte from Exposition Avenue, Denver to York Street, Denver	B_2, C, D_1
Sloan's Lake, Denver, from inlet to outlet	B_3
Main Stem of South Platte from York Street, Denver, to Colo-Nebr. State line	C, D_1
Main Stem of South Platte at State line	B_2, D_1
South & North Forks of South Platte, Tarryall Creek & Goose Creek, including Antero & Tarryall Reservoirs	A, B_1, C, D_1
Bear Creek including Evergreen Lake from source to Town of Morrison	A, B_1, D_1
Bear Creek from Town of Morrison to confluence with South Platte	B_2, D_1
Cherry Creek Reservoir from inlet to outlet	B_2, B_3
Main Stem of Clear Creek from source to point of diversion of Farmers Highline Canal (about 1 mile upstream of Golden)	A, B_1, C, D
Main Stem of Clear Creek from point of diversion of Farmers Highline Canal to confluence with South Platte	A, C, D_1

Table A-1--Stream Classifications, South Platte River Basin, Colorado (Continued)

Stream Reach	Quality Class Effective September, 1971
South Fork of Clear Creek, Chicago Creek, Soda Creek, Beaver Brook, Elk Creek, Guy Gulch & Mill Creek from sources to mouths	A, B_1, C, D_1
Coal Creek from source to intersection with State Highway #93	A, B_1, C, D_1
Coal Creek from intersection with State Highway #93 to mouth	B_2, D_1
South Boulder Creek including Gross Reservoir from source to intersection with State Highway #93	A, B_1, C, D_1
South Boulder Creek from intersection with State Highway #93 to mouth	B_2, C, D_1
North Boulder Creek and James Creek from sources to mouths	A, B_1, C, D_1
Middle Boulder Creek including north and south forks, Barker Reservoir and main stem of Boulder Creek, from sources to intersection with State Highway #119 at mouth of Boulder Canyon	A, B_1, C, D_1
Main Stem of Boulder Creek, from intersection with State Highway #119 at mouth of Boulder Canyon to mouth	B_2, C1, D_1
North and South St. Vrain Creeks from sources to point of confluence at Lyons	A, B_1, C, D_1
Main Stem of St. Vrain Creek, from point of confluence of North & South St. Vrain Creeks at Lyons to confluence with South Platte	C, D_1
Middle St. Vrain Creek from source to mouth	A, B_1

Table A-1--Stream Classifications, South Platte River Basin, Colorado (Continued)

Stream Reach	Quality Class Effective September, 1971
Lefthand Creek from source to intersection with State Highway #7	A, B_1, C, D_1
Lefthand Creek from intersection with State Highway #7 to mouth	C, D_1
Main Stem of Big Thompson River including Lake Estes, from source to Town of Loveland's water treatment plant	A, B_1, C, D_1
Main Stem of Big Thompson River from Town of Loveland's water treatment plant to confluence with South Platte River	C, D_1
Little Thompson River from source to point of diversion for Culver Ditch	A, B_1, D_1
Little Thompson River from point of diversion for Culver Ditch to confluence with Big Thompson River	C, D_1
Glacier Creek, Fall River, North Fork of Big Thompson River and Buckhorn Creek from source to mouth	A, B_1, C, D_1
Carter Lake Reservoir from inlet to outlet	A
Main Stem of Cache La Poudre River, including Horsetooth Reservoir from source to point of diversion for City of Greeley's water treatment plant	A, B_1, D_1
Main Stem of Cache La Poudre from point of diversion for City of Greeley's water treatment plant to Second Avenue Bridge, Greeley	B_2, C, D_1
Main Stem of Cache La Poudre River from Second Avenue Bridge, Greeley to confluence with South Platte	C, D_1

Table A-1 --Stream Classifications, South Platte River Basin, Colorado (Continued)

Stream Reach	Quality Class Effective September, 1971
North and South Forks of Cache La Poudre River from source to mouth	A, B_1, D_1

Notes:

Water Classification A - Public Water Supply
Water Classification B - Fisheries and Body Contact Recreation
B_1- Cold Water Fisheries
B_2- Warm Water Fisheries
B_3- Body Contact Recreation (Swimming, Water Skiing, etc.)
Water Classification C - Industrial Water Users
Water Classification D - Irrigation (& Stock Watering)

WATER QUALITY STANDARDS FOR NEBRASKA
CLASS "C" WATERS

Temperature -

Trout Waters - Allowable change 5°F (maximum list 65°F).

Warm Waters - Allowable change 5°F, May-October; 10°F, November-April; maximum limit 90°F; maximum rate of change limited to 2° per hour.

pH -

The hydrogen iron concentration expressed as pH shall be maintained between 6.5 and 9.0, with a maximum total change of 1.0 pH unit from the value in the receiving stream.

Dissolved Oxygen -

Shall not be lower than 5 mg/l in warm waters and 6 mg/l in trout waters.

Bacteria -

Coliform group and fecal coliform organisms shall not exceed a geometric mean of 10,000 total coliform organisms or 2,000 fecal coliform organisms per 100 ml. No more than 20 percent of the samples shall exceed 20,000 total or 4,000 fecal coliform bacteria.

B.1

APPENDIX B

LIST OF STREAM STATIONS

TABLE B-1
STREAM SAMPLING LOCATIONS IN THE SOUTH PLATTE RIVER BASIN, 1971

Map Key	Figure	Station Description	River Miles	Type of Analysis Performed					
				August-September Surveys			November-December Surveys		
				Chemical	Bacteriological	Biological	Chemical	Bacteriological	Biological
1	2	South Platte River at Waterton Bridge east of water treatment plant.	339.2	X	X	X			
2	2	South Platte River at Blakeland Road.	336.5	X		X			
3	2	South Platte River at Colorado "470" Bridge.	334.9	X		X			
4	2	South Platte River downstream from Cooley Sand and Gravel Company.	332.3			X			
5	2	South Platte River at Bowles Avenue in Littleton, Colorado.	329.8	X	X	X			
6	2	Bear Creek near Mouth (at Federal Boulevard)	326.4/0.7	X	X	X			
7	2	Bear Creek at Kipling.	326.4/5.9	X		X			
8	2	Bear Creek upstream of Morrison along Colorado 74 (Second Suspended Walkway across Creek).	326.4/13.0	X	X	X			
9	2	South Platte River at Florida Avenue	323.2	X		X			
10	2	South Platte River upstream of Cherry Creek.	317.8	X		X			
11	2	Cherry Creek at Mouth.	317.7/0.1	X	X	X			
12	2	South Platte River at "19th" Street Bridge.	317.3	X	X	X	X	X	X
13	2	South Platte River at North Denver Waste Water Treatment Plant Crossover.	314.5				X	X	
14	2	South Platte River at York Street.	313.4	X	X	X	X	X	X

TABLE B-1 (Continued)
STREAM SAMPLING LOCATIONS IN THE SOUTH PLATTE RIVER BASIN, 1971

Map Key	Figure	Station Description	River Miles	Type of Analysis Performed					
				August-September Surveys			November-December Surveys		
				Chemical	Bacteriological	Biological	Chemical	Bacteriological	Biological
15	2	Burlington Ditch at York Street.					X	X	X
16	2	Sand Creek at Mouth.	312.1/0.1	X	X	X			
17	2	South Platte River at I-270.	312.0				X	X	X
18	2	South Platte River at I-80.	311.5			X			
19	2	Clear Creek at York Street.	311.1/0.3	X	X	X	X	X	X
20	2	Clear Creek at Kipling.	311.1/10.4	X		X			
21	2	Clear Creek at McIntyre Road.	311.1/14.1	X	X				
22	2	Clear Creek upstream of Golden	311.1/18.7	X	X	X			
23	2	South Platte River at Colorado 224.	310.9				X	X	X
24	2	South Platte River at 88th Avenue.	306.8	X		X	X	X	X
25	2	South Platte River at Henderson.	301.7	X	X	X			
26	3	South Platte River at Brighton.	296.1	X		X		X	X
27	3	South Platte River downstream from Waste Water Treatment Plant at Brighton.	295.7					X	X
28	3	South Platte River downstream from Great Western at Brighton.	294.4					X	X
29	3	South Platte River at Ft. Lupton.	289.2	X	X	X			
30	3	South Platte River at Platteville.	276.7	X	X	X		X	X
31	3	South Platte River upstream of Mouth of St. Vrain Creek.	270.1	X	X				

TABLE B-1 (Continued)
STREAM SAMPLING LOCATIONS IN THE SOUTH PLATTE RIVER BASIN, 1971

Map Key	Figure	Station Description	River Miles	Type of Analysis Performed					
				August-September Surveys			November-December Surveys		
				Chemical	Bacteriological	Biological	Chemical	Bacteriological	Biological
32	3	South Platte River downstream from St. Vrain Creek.	264.7	X	X	X	X	X	X
33	3	St. Vrain upstream of Longmont.	270.0/26.6	X	X	X	X		
34	3	St. Vrain upstream of Great Western Sugar Company.	270.0/22.5		X				X
35	3	St. Vrain downstream from Longmont County Line Road.	270.0/20.8	X	X	X	X		
36	3	St. Vrain downstream from Longmont County Line Road.	270.0/20.6		X				X
37	3	St. Vrain at I-25.	270.0/14.6	X		X			
38	3	St. Vrain near Mouth.	270.0/1.3	X	X	X			
39	3	Boulder Creek upstream of Boulder State Highway 119.	270.0/17.4/27.6	X	X	X			
40	3	Boulder Creek downstream from Boulder at 55th Street downstream from Pearl Street Waste Water Treatment Plant.	270.0/17.4/21.0	X		X			
41	3	Boulder Creek downstream from South Boulder Creek, 1/2 mile north of Valmont.	270.0/17.4/19.9	X	X	X			
42	3	Boulder Creek County Road 19 near Liggett.	270.0/17.4/14.2	X		X			
43	3	Coal Creek just upstream of Mouth.	270.0/17.4/7.9/1.0	X	X				
44	3	Boulder Creek downstream from Coal Creek at Highway 52.	270.0/17.4/7.3	X	X	X			
45	3	Boulder Creek near Mouth.	270.0/17.4/1.9	X	X	X			

TABLE B-1 (Continued)
STREAM SAMPLING LOCATIONS IN THE SOUTH PLATTE RIVER BASIN, 1971

Map Key	Figure	Station Description	River Miles	Type of Analysis Performed					
				August-September Surveys			November-December Surveys		
				Chemical	Bacteriological	Biological	Chemical	Bacteriological	Biological
46	3	South Platte River downstream from Big Thompson River between Evans and LaSalle at Highway U.S. 85.	256.1	X	X				
47	3	Big Thompson River West of Loveland on U.S. Highway 34 (3rd Bridge)Fawn Hollow.	260.4/37.9	X	X	X			
48	3	Big Thompson River Two Miles West of I-25 on Colorado State Highway 402 1/4 mile north on Road 9E.	260.4/23.5	X	X	X	X	X	X
49	3	Big Thompson River downstream from Great Western at Loveland.	260.4/21.0	X			X	X	
50	3	Big Thompson River South of Officer one mile; east 1/2 mile on Weld County Road 54.	260.4/16.5	X		X			
51	3	Big Thompson River at Route 257, Milliken.	260.4/8.2	X		X			
52	3	Big Thompson River at Mouth.	260.4/0.9	X	X	X			
53	3	Little Thompson River South and West of Berthoud.	260.4/7.0/18.9	X	X	X			
54	3	Little Thompson River at I-25.	260.4/7.0/11.1	X	X	X			
55	3	Little Thompson River upstream of Great Western at Johnstown.	260.4/7.0/4.0	X			X	X	X
56	3	Little Thompson River downstream from Great Western at Johnstown on Colorado 60 Bridge.	260.4/7.0/1.15	X			X	X	X
57	3	Little Thompson River at Mouth.	260.4/7.0/0.1	X	X	X			

TABLE B-1 (Continued)
STREAM SAMPLING LOCATIONS IN THE SOUTH PLATTE RIVER BASIN, 1971

Map Key	Figure	Station Description	River Miles	Type of Analysis Performed: August-September Surveys: Chemical	Bacteriological	Biological	November-December Surveys: Chemical	Bacteriological	Biological
58	3	South Platte River upstream of Cache la Poudre River near Evans.	252.5	X	X	X			
59	3	South Platte River 1 Mile upstream of Mouth of Cache la Poudre River.	250.6	X	X		X	X	X
60	3	Cache la Poudre River upstream of Bellvue off Highway 287 at Highway 54E.	249.0/53.6	X	X	X			
61	3	Cache la Poudre River upstream of Fort Collins at Shields Avenue Bridge.	249.0/46.8	X	X				
62	3	Cache la Poudre River at Prospect Avenue in Fort Collins.	249.0/41.2	X	X	X			
63	3	Cache la Poudre River at Timnath Road.	249.0/36.3	X	X	X			
64	3	Cache la Poudre River upstream of Windsor.	249.0/26.5	X	X	X			
65	3	Cache la Poudre River downstream from Windsor and South of Bracewell.	249.0/17.9	X	X	X			
66	3	Cache la Poudre River at Spanish Colony.	249.0/9.4	X	X	X			
67	3	Irrigation return near Spanish Colony.	249.0/9.35	X					
68	3	Cache la Poudre River upstream of Eaton Draw.	249.0/7.0	X			X	X	X
69	3	Eaton Draw at Mouth.	249.0/6.9/0.1	X			X	X	
70	3	Eaton Draw downstream from Eaton Waste Water Treatment Plant.	249.0/6.9/6.5	X			X	X	
71	3	Eaton Draw upstream of sugar factory.	249.0/6.9/7.2	X			X	X	
72	3	Cache la Poudre River at 6th Avenue, Greeley.	249.0/6.3	X	X		X	X	X

TABLE B-1 (Continued)
STREAM SAMPLING LOCATIONS IN THE SOUTH PLATTE RIVER BASIN, 1971

Map Key	Figure	Station Description	River Miles	Type of Analysis Performed					
				August-September Surveys			November-December Surveys		
				Chemical	Bacteriological	Biological	Chemical	Bacteriological	Biological
73	3	Cache la Poudre River downstream of Greeley Waste Water Treatment Plant.	249.0/5.2	X			X	X	
74	3	Cache la Poudre River on County Road South of Greeley Airport.	249.0/12.9					X	
75	3	Cache la Poudre River near mouth at Davis Ranch.	249.0/0.5	X	X	X	X	X	
76	3	South Platte River at Kersey.	246.5	X	X	X	X	X	X
77	4	South Platte River at Weldona, South on Highway.	203.9			--Gaging	Station	Only--	
78	4	South Platte River upstream of Great Western Discharge at Fort Morgan.	197.0					X	X
79	4	South Platte River at Fort Morgan (Colorado 52 Bridge).	196.6				X		X
80	4	South Platte River downstream from Great Western Discharge at Fort Morgan.	195.4				X	X	X
81	4	South Platte River at Balzac.	174.0			--Gaging	Station	Only--	
82	4	South Platte River - South Sterling.	151.6			X[a]	X	X	X
83	4	South Platte River downstream from Great Western Discharge at Sterling.	150.0				X	X	X
84	4	South Platte River at Ovid (Bridge on Colorado 23).	95.4			X	X	X	X
85	4	Liddle Ditch downstream from Lodgepole Creek at Overflow Structure.	95.1				X	X	

[a] Electroshock for fish at river mile 158.1

TABLE B-1 (Continued)
STREAM SAMPLING LOCATIONS IN THE SOUTH PLATTE RIVER BASIN, 1971

Map Key	Figure	Station Description	River Miles	Type of Analysis Performed					
				August-September Surveys			November-December Surveys		
				Chemical	Bacteriological	Biological	Chemical	Bacteriological	Biological
86	4	South Platte River downstream from Ovid.	96.0				X	X	X
87	4	South Platte River at Julesburg (Bridge on U.S. 385)	87.0				X	X	X
88	4	South Platte River downstream from Nebraska-Colorado State Line (I-80 Bridge).	81.1				X	X	X

APPENDIX C

STUDY METHODS

WASTE SOURCE EVALUATIONS

Twenty-three municipal and 45 industrial sources were investigated. Background data on these sources were collected from existing files (South Platte River Basin Project records and reports), municipal and industrial inventories, Colorado implementation plans State and local pollution control authorities, and industrial officials.

Where possible the municipal waste sources were sampled for three days. The Metropolitan Denver Sewage Disposal District #1 Plant (Metro) was sampled for eight days. Influent and effluent sampling was generally conducted; however, intermediate points were sampled at some plants--e.g., Metro. Water samples were collected manually or by the use of automatic sampling equipment (SERCO) and composited on a 24-hour, flow-weighted basis. Chemical analyses included BOD, TOC, solids, and, at selected stations, COD, metals, and nutrients. Periodic measurements were made for pH, conductivity, temperature, and chlorine residual (effluent only). Grab samples of water were collected for bacteriological analyses several times each day. When flow measuring devices were not available at a plant, such equipment was installed. In most instances a Parshall flume was available. When necessary, continuous flow recorders (Stevens Model F) were used.

Of the 45 industries visited, 23 were selected for sampling of which nine were Great Western Sugar Company plants. Automatic sampling equipment was used at the nine Great Western plants and at the Adolph Coors Company. These samples were composited on an equal volume basis.

Water samples at the other industries were generally collected over an eight-hour period as grab samples and then composited. Measurements were made for pH, conductivity, and temperature during the sampling period. Bacteriological samples were collected periodically at the Great Western plants and Coors. Where possible flows were measured and recorded continuously; otherwise, estimates were made.

After collection all samples were iced and transported to the NFIC-Denver laboratory for analyses. Laboratory personnel split the samples and added the necessary preservatives.

STREAM SURVEYS

Chemical, Physical, and Bacteriological Parameters

The stream surveys were conducted during August-September and November-December 1971. Eighty-six stations [Table B-1] were sampled. The sampling for chemical and bacteriological analyses was generally four to five days in duration. The time of sampling at each station was varied to obtain the maximum time spread. During the summer survey, a dissolved oxygen profile was conducted over a 24-hour period at selected stations in the following reaches:

1. South Platte River, Waterton to Platteville.

2. South Platte River from upstream of mouth of St. Vrain Creek to downstream from the mouth of the Big Thompson River.

3. Cache la Poudre River from Bellvue downstream to the mouth including the South Platte River upstream and downstream from the mouth of the Cache la Poudre.

All samples were collected using established sampling procedures. Samples for chemical analyses were collected in clean, unused containers; those for bacteriological analyses were collected in sterile glass containers. The dissolved oxygen samples were collected in 300 ml bottles using a Sargent sampler. All samples were iced and transported to the NFIC - Denver laboratory in Denver. The chemistry samples were then split and preserved for specific analyses by laboratory personnel.

The pH, conductivity, and temperature were measured in the field at the time of sampling. Flow data were collected from existing gaging stations where possible. In addition, stream flow measurements were made at selected stations.

Bacteriological analyses for total and fecal coliform and for streptococcus were performed, according to the method prescribed in the 13th Edition, Standard Methods for the Examination of Water and Wastewater, 1971* using the membrane filter technique.

The BOD and dissolved oxygen tests were determined, according to the method prescribed in the 13th Edition, Standard Method for the Examination of Water and Wastewater, 1971* using the azide modification of the Winkler method.

All other laboratory analyses and field measurements used were conducted in accordance with Methods for Chemical Analyses of Water and Wastes, July 1971.**

---

*Standard Methods for the Examination of Water and Wastewater, 13th Edition, American Public Health Association, New York, New York, 1971.

**Methods for Chemical Analysis of Water and Wastes, Environmental Protection Agency, National Environmental Research Center, Analytical Quality Control Laboratory, Cincinnati, Ohio, 1971.

BIOLOGICAL PARAMETERS

Algae

Periphyton or attached algal growths were sampled using artificial substrates, 1 X 3-inch glass microscope slides. The substrate assemblies consisted of five slides attached to building bricks with glazier's putty. After a 10-day exposure in the stream, four slides from each substrate assembly were placed in 90 percent acetone for subsequent chlorophyll analysis. The fifth slide was placed in 5 percent formalin to determine periphyton density and to identify prevalent algal types.

In the laboratory, the slides preserved in acetone were scraped and rinsed off into the acetone solution. The chlorophyll-bearing acetone was centrifuged to remove suspended particulate matter and concentrations of chlorophyll were determined with a recording spectrophotometer. Previous studies revealed little or no chlorophyll *b* or *c* in South Platte River Basin periphyton samples; therefore, only chlorophyll *a* was measured and recorded in this report. The equation used for expressing chlorophyll on an areal basis from the substrate was:

Chlorophyll $\underline{A} = \frac{C \times S}{A}$ = micrograms/sq. inch

where: C = concentration of chlorophyll in acetone solute (μg/ml)

S = milliliters of acetone solute

A = square inches of substrate

The slide preserved in 5 percent formalin solution was used to determine periphyton density and prevalent algal types. Attached algae were scraped and rinsed off into a formalin solution. A one-milliliter aliquot was counted in a Sedgwick-Rafter counting cell and the cells per unit area computed. Prevalent types of algae were identified and recorded.

Benthos

Bottom-dwelling invertebrates were sampled using Hester-Dendy artificial substrates and standard quantitative bottom sampling gear. The artificial substrates were placed in situ for 42 to 49 days. The sample collected was brushed off the plates and preserved in 5 percent formalin. Two kinds of quantitative bottom samplers were used: (1) Surber square-foot sampler and (2) Petersen grab (dredge). The sampled streams were generally shallow, so the majority of quantitative sampling was done with the Surber sampler. A qualitative sample was taken at each biological stream station also. All samples were preserved in 10 percent formalin. In the laboratory, the preserved organisms were separated from debris, identified and counted. Results from the artificial substrates were expressed as number of animals per substrate; results from Petersen and Surber samplers were expressed as number of animals per square foot. Organisms collected in qualitative samples only were arbitrarily assigned values of one per square foot of stream bed, and were counted with the quantitative samples.

In the report macroinvertebrates were classified into three categories depending upon their reaction to environmental stress:*

1. Intolerant - organisms that live in a restricted range of environmental conditions. They exhibit a negative reaction to enriched conditions. Included in this category were immature stoneflies, caddisflies and mayflies.
2. Facultative - organisms that can withstand a wide range of environmental conditions and that thrive in moderate organic enrichment. These forms are not commonly found in grossly polluted conditions; e.g. immature dragonflies, damselflies, midges (except Chironomus), scuds, etc.

3. Tolerant - organisms that can withstand adverse environmental conditions. Commonly found in clean to polluted streams, but they often exhibit a positive reaction to gross organic enrichment by a drastic increase in numbers; e.g. sludgeworms, leeches, midges (*Chironomus*), etc.

Fish

Quantitative sampling of fish was done with modified trap nets in the South Platte River (RM 339.2 to 332.3) and in the Cache la Poudre River. Four nets were fished at each location for 24-hour periods and data were expressed as the equivalent catch for four net days. Fish were collected also in the South Platte River Basin by electroshocking.

APPENDIX D

CHEMICAL AND ANALYTICAL RESULTS FOR STREAM SURVEYS

TABLE D-1

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA FOR STREAM SURVEYS ON TRIBUTARIES IN THE DENVER METROPOLITAN AREA
BEAR CREEK, CHERRY CREEK, SAND CREEK AND CLEAR CREEK
AUGUST 30-SEPTEMBER 2, 1971

Map Key a/	Station Description		Flow CFS	Temp °C	Cond µmhos/cm	pH S.U.	Dissolved Oxygen		BOD mg/l	TOC mg/l	Solids mg/l		Alkalinity mg/l	mg/l as N			Total P (mg/l)
							mg/l	% Sat			Total	Suspended		NH_3 - N	K_J - N	$NO_2 + NO_3$	
	Bear Creek																
8	Bear Creek upstream of Morrison (RM 326.4/13.0)	AVERAGE		-	-	-	7.6	95	2.5	1c/	80	25	30	0.2	2	0.18	0.3
		RANGE		13.5-20.0	60-80	7.4-8.3	7.2-8.2	85-105	0.7-5.0	-	60-110	18-32	29-30	0.1-0.2	1-3	0.10-0.27	0.2-0.3
7	Bear Creek at Kipling (RM 326.4/5.9)	AVERAGE		-	-	-	6.8	91	1.3	-	273	20	162	-	-	-	-
		RANGE		15.0-24.0	335-450	7.5-8.2	5.7-8.2	72-114	1.2-1.3	-	220-320	10-30	160-164	-	-	-	-
5	Bear Creek at Mouth (at Federal Blvd.) (RM 326.4/0.7)	AVERAGE	21.8	-	-	-	8.5	110	1.9	2	360	15	215	0.2	3	0.33	0.1c/
		RANGE	21.7-21.8	15.0-23.0	460-625	7.8-8.8	6.0-11.3	72-150	1.1-2.6	1-2	300-400	12-26	212-218	0.1-0.2	1-5	0.12-0.54	-
	Cherry Creek																
11	Cherry Creek at Mouth (RM 317.7/0.1)	AVERAGE		-	-	-	8.3	110	4.3	3	585	34	192	0.2	4c/	1.6	0.4c/
		RANGE	9.01-17.8	16.5-24	560-850	7.7-9.7	5.5-11.4	75-155	2.0-7.6	1-4	530-660	18-60	192-193	0.2-0.3	-	1.5-1.7	-
	Sand Creek																
16	Sand Creek at Mouth (RM 312.1/0.1)	AVERAGE	102.7	-	-	-	6.8	89	7.8	7	572	203	126	0.3	2.8	1.06	0.6
		RANGE	95.9-109.5	17-19	420-600	7.5-8.0	6.4-7.3	86-95	6.3-9.4	2-14	380-1,300	28-830	125-127	0.2-0.5	1.0-5.4	.98-1.10	0.5-0.7
	Clear Creek																
22	Clear Creek upstream of Golden (RM 311.1/18.7)	AVERAGE	185	-	-	-	8.2	98	1.2	2	170	57	44	0.2	.3	0.18	0.2c/
		RANGE	172-204	13.5-18.0	180-210	7.9-8.4	7.2-9.1	92-105	0.9-1.8	1-3	120-260	21-130	43-45	0.2-0.3	.2-.3	0.16-0.20	-
21	Clear Creek at McIntire Road (RM 311.1/14.1)	AVERAGE	-	-	-	-	5.2	66	8.0	-	272	92	66b/	-	-	-	-
		RANGE	-	16-22.5	220-300	7.4-7.9	3.4-7.0	42-86	5.0-13	-	180-450	32-270	-	-	-	-	-
20	Clear Creek at Kipling Street (RM 311.1/10.1)	AVERAGE	-	-	-	-	6.5	84	5.9	-	258	35	64	-	-	-	-
		RANGE	-	16.5-25.0	215-340	6.8-8.0	5.2-7.5	65-93	4.5-7.6	-	200-420	15-55	63-64	-	-	-	-
19	Clear Creek at York Street (RM 311.1/0.3)	AVERAGE	21	-	-	-	6.7	88	4.0	3	379	35	120b/	0.4	.7	1.3	0.7c/
		RANGE	16-28	16-21	470-600	7.3-8.4	4.8-8.6	62-115	2.9-5.2	1-4	300-469	10-60	-	0.3-0.5	.6-.9	1.0-1.5	-

---

a/ See Figure 2.
b/ One value.
c/ All values the same.

TABLE [illegible]

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA AT SELECTED STATIONS ON ST. VRAIN AND BOULDER CREEKS
SEPTEMBER 7-10, 1971

Map Key[a]	Station Description		Flow CFS	Temp °C	Cond. µmhos/cm	pH S.U.	Dissolved Oxygen		BOD mg/l	TOC mg/l	Solids mg/l		Alkalinity mg/l	mg/l as N			Total P mg/l
							mg/l	% Sat			Total	Suspended		NH_3 - N	Kj - N	$NO_2 + NO_3$	
	St. Vrain Creek																
33	St. Vrain Creek upstream of Longmont (RM 270.0/26.6)	AVERAGE RANGE		- 16.0-25.0	- 260-340	- 6.9-7.9	7.8 6.9-8.7	99 85-115	1.3 1.2-1.5	5 1-7	205 170-260	8 4-17	67 60-80	0.2 0.1-0.3	0.3 0.2-0.3	0.39 0.39-1.6	0.1[b]
35	St. Vrain Creek downstream of Longmont (City Line Road) (RM 270.0/20.8)	AVERAGE RANGE		- 14.5-24.0	- 520-1,200	- 7.6-8.1	8.4 6.5-9.7	111 86-134	5.4 1.3-10	- -	630 390-710	16 8-30	65 64-67	- -	- -	- -	- -
39	Boulder Creek upstream of Boulder State Highway 119 (RM 270.0/17.4/27.6)	AVERAGE RANGE	56 19-67	- 11.0-16.5	- 70-440	- 7.3-7.5	8.5 8.0-8.9	97 92-102	0.9 0.8-1.0	2 1-4	65 40-80	8	22 19-25	0.2 0.1-0.2	0.3 0.1-0.5	0.61 0.03-1.8	0.1 0.1-0.2
40	Boulder Creek downstream from Boulder at 55th Street (RM 270.0/17.4/21.0)	AVERAGE RANGE		- 13.5-21.0	- 200-480	- 6.8-7.4	7.1 6.4-8.2	88 79-102	14 13-14	- -	185 110-260	9 7-19	78 77-78	- -	- -	- -	- -
41	Boulder Creek downstream from South Boulder Creek (RM 270.0/17.4/19.9)	AVERAGE RANGE		- 14-22.5	- 260-400	- 6.7-7.8	6.7 4.7-8.3	85 65-106	8.8 -	5 4-11	185 140-230	13 8-30	97 94-100	1.6 0.7-3.2	2.8 1.6-4.9	1.11 0.37-2.2	1.2 0.8-1.9
42	Boulder Creek County Road 19 near Liggett (RM 270.0/17.4/14.2)	AVERAGE RANGE		- 14.0-22.0	- 400-470	- 7.5-8.0	7.6 6.4-8.6	95 73-110	6.5 6.4-6.6	- -	267 250-280	16 8-48	- -	- -	- -	- -	- -
43	Coal Creek upstream of Mouth (RM 270.0/17.4/7.9/1.0)	AVERAGE RANGE	2.8 2.5-3.1	- 12.0-24.5	- 1,100-1,200	- 6.2-8.3	8.3 7.5-9.4	102 81-125	9.0 6.5-13	- -	845 770-890	19 8-39	- -	- -	- -	- -	- -
44	Boulder Creek downstream from Coal Creek at Highway 52 (RM 270.0/17.4/7.3)	AVERAGE RANGE		- 14.5-25.0	- 490-650	- 6.5-8.9	10.6 8.4-13.7	145 99-196	6.1 5.0-8.0	- -	377 300-450	27 7-49	152[c] -	- -	- -	- -	- -
45	Boulder Creek near Mouth (RM 270.0/17.4/1.9)	AVERAGE RANGE	6.7 5.9-7.9	- 14.0-25.5	- 1,200-1,400	- 7.9-8.6	12.1 9.4-14.6	154 110-209	1.7 1.4-4.3	9 3-17	975 900-1,080	- -	29 27-30	0.4 0.3-0.5	0.8 0.5-1.0	0.87[b] -	0.4 0.3-0.5
37	St. Vrain Creek at I-25 (RM 270.0/14.6)	AVERAGE RANGE		- 16.0-24.0	- 1,100-1,450	- 7.5-8.3	8.8 6.6-10.5	120 86-148	3.9 3.4-4.4	7 4-9	1,020 910-1,240	42 6-79	- -	0.3 0.2-0.4	1.0 0.6-1.6	2.1 1.9-2.3	0.4 0.4-0.5
38	St. Vrain Creek near Mouth (RM 270.0/1.3)	AVERAGE RANGE	211 178-232	- 17.0-23.5	- 1,100-1,500	- 6.5-8.2	7.2 4.3-8.7	91 60-110	3.7 2.3-5.6	6 6-7	1,075 950-1,230	43 10-110	21 20-24	0.3 0.2-0.3	0.5 0.3-0.6	2.4 2.1-2.7	0.5 0.4-0.6

---

a/ See Figure 3.
b/ All values the same.
c/ One value.

TABLE D-3

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA AT SELECTED STATIONS ON ST. VRAIN CREEK
DECEMBER 6-10, 1971

Map Key[a/]	Station Description		Flow CFS	Temp. °C	Cond. µmhos/cm	pH S.U.	Dissolved Oxygen mg/l	Dissolved Oxygen % Sat.	BOD mg/l	Alkalinity mg/l
36	St. Vrain River downstream from Great Western at Longmont, Colorado (RM 270.0/20.6)	AVERAGE	56.0	-	-	-	2.1	-	55	251
		RANGE	52.0-57.8	5.0-13.0	1,200-1,380	7.7-8.4	0.3-3.7	3-33	45-65	230-265
34	St. Vrain River upstream of Great Western at Longmont, Colorado (RM 270/22.5)	AVERAGE	38.6	-	-	-	11.3	-	3	214
		RANGE	34.5-40.3	0.0-1.0	825-1,350	7.7-8.3	10.4-12.6	85-106	2-6	198-230

[a/] See Figure 3.

TABLE D-4

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA AT SELECTED STATIONS ON THE BIG AND LITTLE THOMPSON RIVERS
SEPTEMBER 7-10, 1971

Map Key[a]	Station Description		Flow CFS	Temp. °C	Cond. µmhos/cm	pH S.U.	Dissolved Oxygen mg/l	Dissolved Oxygen % Sat	BOD mg/l	TOC mg/l	Solids mg/l Total	Solids mg/l Suspended	Alkalinity mg/l	mg/l as N $NH_3 - N$	mg/l as N $K_j - N$	mg/l as N $NO_2 + NO_3$	Total P mg/l
	Big Thompson River Basin																
47	Big Thompson River (BTR) west of Loveland on U.S. 34 Fawn Hallow (RM 260.4/37.9)	AVERAGE		-	-	-	8.2	88	2.0	<6	377	[illegible]	-	0.2	0.3	0.17	0.3
		RANGE		15-17	60-100	7.2-7.7	7.7-8.7	83-93	1.6-2.5	<1-7	50-820	8-30	-	0.1-0.3	0.1-0.4	0.03-0.50	0.1-0.4
48	BTR two miles west of I-25 on Colorado 402 1/4 mile north on Road 9E (RM 260.4/23.5)	AVERAGE		-	-	-	8.5	98	5.8	8	570	30	-	0.5	1.5	0.90	0.7
		RANGE		15-21	800-1,100	7.5-8.5	6.5-9.8	76-118	5.2-6.8	7-8	480-710	6-48	-	0.2-0.8	1.1-2.1	0.53-1.4	0.5-1.0
50	BTR south of Officer one mile east 1/2 mile on Weld County 54 (RM 260.4/16.5)	AVERAGE		-	-	-	11.9	135	2.4	5	788	18	-	0.2	0.6	1.2	0.5
		RANGE		15-20	675-1,300	7.6-8.6	8.9-15.7	103-150	1.2-3.1	3-9	670-950	7-35	-	0.2-0.3	0.3-0.8	0.85-1.6	0.4-0.5
51	BTR at Route 257 Milliken (RM 260.4/8.2)	AVERAGE	25	-	-	-	9.3	110	1.6	5	1,370	21	-	0.3	0.4[b]	1.4	0.3
		RANGE	21-28	14-19	1,600-2,000	7.8-8.3	7.7-10.8	79-115	1.0-2.7	2-9	1,120-1,670	8-59	-	0.2-0.4	-	0.87-2.2	0.2-0.5
53	Little Thompson River (LTR) south and west of Berthoud (RM 260.4/7.0/18.9)	AVERAGE		-	-	-	7.1	84	3.6	6	1,970	9	-	0.2	0.7	[illegible]	0.3
		RANGE		17-25	2,400-3,750	7.9-8.3	6.0-8.1	66-115	2.0-6.8	5-8	1,880-2,130	7-19	-	0.2-0.3	0.4-0.8	0.9-2.7	0.1-0.4
54	LTR at I-25 (RM 260.4/7.0/11.1)	AVERAGE		-	-	-	6.9	80	6.1	-	3,210	378	-	-	-	-	-
		RANGE		15-22	2,700-3,500	7.9-8.1	5.3-8.4	65-89	3.7-8.4	-	2,770-4,190	61-1,250	-	-	-	-	-
57	LTR at Mouth (RM 260.4/7.0/0.1)	AVERAGE	63	-	-	-	6.8	75	4.1	12	2,520	225	-	0.4	1.0	3.0	0.8
		RANGE	54-72	14-18.5	2,600-4,000	7.9-8.1	6.4-7.0	72-77	3.8-4.2	11-13	2,250-2,940	132-440	-	0.3-0.5	0.4-1.6	2.9-3.2	0.7-1.0
52	BTR at Mouth (RM 260.4/0.9)	AVERAGE	[illegible]	-	-	-	7.5	86	3.1	8	1,760	140	26	0.3	0.7	2.3	0.6
		RANGE	92-108	14-21	1,700-3,000	7.4-8.0	7.0-8.0	76-98	2.6-3.7	6-11	1,050-2,160	90-169	25-26	0.2-0.4	0.5-0.8	2.2-2.4	0.4-1.0

---

a/ See Figure 3.
b/ All values the same.

TABLE D-5

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA AT SELECTED STATIONS ON THE BIG AND LITTLE THOMPSON RIVERS
DECEMBER 6-10, 1971

Map Key	Station Description		Flow CFS	Temp. °C	Cond. µmhos/cm	pH S.U.	Dissolved Oxygen		BOD mg/l	Alkalinity mg/l
							mg/l	% Sat.		
48	Big Thompson River upstream of Great Western at Loveland, Colorado (RM 260.4/23.5)	AVERAGE	12.4	-	-	-	9.7	-	17	203
		RANGE	12.4-12.4	0.0-4.5	1,350-1,500	7.4-8.2	7.6-11.0	62-104	12-24	196-215
49	Big Thompson River downstream from Great Western at Loveland, Colorado (RM 260.4/21.0)	AVERAGE	18.2	-	-	-	8.4	-	16	238
		RANGE	9.3-25.3	0.0-4.5	975-1,200	7.8-8.1	7.9-8.9	65-75	11-24	223-248
56	Little Thompson River downstream from Great Western at Johnstown, Colorado (RM 260.4/7.0/1.15)	AVERAGE	25.1	-	-	-	5.8	-	82	354
		RANGE	24.9-25.4	0.5-4.5	1,400-3,250	7.9-8.3	4.0-7.0	37-58	46-148	322-403
55	Little Thompson River upstream of Great Western at Johnstown, Colorado (RM 260.4/7.0/4.0)	AVERAGE	20.7	-	-	-	10.6	-	4	317
		RANGE	20.7	0.0-2.5	2,750-3,500	7.9-8.4	10.4-10.7	86-87	2-7	299-338

TABLE [illegible]

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA AT SELECTED STATIONS ON THE CACHE LA POUDRE RIVER

SEPTEMBER 13-16, 1971

Map Key a/	Station Description		Flow cfs	Temp. °C	Cond. µmhos/cm	pH S.U.	Dissolved Oxygen mg/l	Dissolved Oxygen % Sat	BOD_5 mg/l	TOC mg/l	Solids mg/l Total	Solids mg/l Susp.	Turbidity JTU	Alkalinity, mg/l	mg/l as N NH_3 - N	mg/l as N K_j - N	mg/l as N $NO_2 + NO_3$	Total P mg/l
60	Cache la Poudre River (CLPR) upstream of Bellevue off Highway 287 at Highway 54E (RM 249.0/51.60)	AVERAGE	266	-	-	-	9.6	106	0.9	1	61	7	2.9	30	0.2	0.2	0.6	0.1 b/
		RANGE	230-302	11-14	60-85	7.1-7.3	9.2-10.4	100-114	0.9-1.0	1-1	30-120		1.1-4.5	28-36	0.2-0.3	0.2-0.3	-	-
61	CLPR upstream of Fort Collins at Shields Avenue Bridge (RM 249.0/46.80)	AVERAGE	-	-	-	-	12.3	102	1.2		90	5	3.6	41	-	-	-	-
		RANGE	-	10.0-14.5	130-160	7.7-8.0	10-14.5	95-111	1.1-1.4		60-150	5-15	2.6-4.5	39-46	-	-	-	-
62	CLPR at Prospect Avenue in Fort Collins (RM 249.0/41.2)	AVERAGE	55.5	-	-	-	7.7	86	7.4	1 b/	422	13	8.4	142	0.3 b/	1.1	0.76	1.2
		RANGE	35.8-79.6	11.0-15.0	430-750	7.3-8.3	7.4-10.1	48-120	6.6-8.2	-	320-570	9-19	7.0-17	113-171	-	-	0.69-0.84	1.0-1.3
63	CLPR at Timnath Road (RM 249.0/36.1)	AVERAGE	-	-	-	-	5.5	61	5.1	4	1,620	9	4.0	252	1.7	3.0	2.7	1.0
		RANGE	-	11.0-14.5	1,600-2,000	7.5-7.7	3.7-6.5	41-71	4.0-6.6	2-5	1,560-1,700	7-15	2.5-4.8	247-257	1.0-2.4	2.9-3.2	-	0.7-1.3
64	CLPR upstream of Windsor (RM 249.0/26.5)	AVERAGE	-	-	-	-	9.4	108	3.9	5	1,100	38	14	195	0.3 b/	1.0	1.2	0.4 b/
		RANGE	-	11.5-14.5	1,300-1,450	7.9-8.2	8.7-10.1	103-112	3.8-4.0	4-6	1,010-1,260	30-50	7.3-18	187-209	-	1.0-1.1	1.1-1.3	-
65	CLPR downstream from Windsor and south of Bracewell (RM 249.0/17.4)	AVERAGE	-	-	-	-	8.9	101	3.4	-	1,360	35	8.9	230	-	-	-	-
		RANGE	-	11.5-15	1,500-1,700	7.8-8.0	9.0-10.4	90-116	3.1-3.8	-	1,200-1,460	29-41	2.6-16	222-248	-	-	-	-
66	CLPR at Spanish Colony (RM 249.0/9.4)	AVERAGE	19.7	-	-	-	10.9	121	1.9	3	1,780	8	4.8	275	0.2	0.6	4.5	0.1
		RANGE	12.4-49	11-14	1,750-2,100	7.6-8.1	8.7-13.9	96-155	1.5-2.3	2-4	1,690-1,940	4-12	4.5-5.0	260-290	0.2-0.3	0.5-0.6	4.3-4.7	0.1-0.2
67	Irrigation return near Spanish Colony (RM 249.0/9.35)	AVERAGE	7.49	-	-	-	9.0	99	7.0	-	1,820	310	120	206	-	-	-	-
		RANGE	6.05-8.61	10.5-12.0	1,350-2,600	7.9-8.1	8.6-9.4	96-101	5.2-8.8	-	1,390-2,010	250-350	85-140	167-315	-	-	-	-
69	Eaton Draw at Mouth (RM 249.0/6.9/0.11)	AVERAGE	1.53 c/	-	-	8.5 b/	8.2	92	11	10	1,370	100	42	201	0.2	1.4	3.8	0.4
		RANGE	1.32-1.74	10.5-14.0	1,450-1,900		7.6-9.1	85-101	10-11	8-12	1,270-1,550	42-170	22-60	200-202	0.2-0.3	1.3-1.6	3.7-3.9	0.3-0.5
70	CLPR at 6th Avenue, Greeley (RM 249.0/8.1)	AVERAGE	-	-	-	-	7.6	86	3.4	-	1,400	50	20	256	-	-	-	-
		RANGE	-	11-14	2,000-2,500	7.9-8.2	6.9-8.5	75-100	3.2-3.5	-	620-1,720	43-73	7.3-30	247-282	-	-	-	-
71	CLPR downstream from Greeley STP (RM 249.0/5.2)	AVERAGE	-	-	-	-	5.5	62	27	-	1,470	76	31	251	-	-	-	-
		RANGE	-	10-14	1,800-2,600	7.7-8.1	3.9-6.8	43-80	[illegible]	-	1,410-1,550	30-142	17-60	237-275	-	-	-	-
75	CLPR near Mouth at Kuner Bridge (RM 249.0/2.4)	AVERAGE	80.1	-	-	-	5.1	61	10	5	1,440	31	12	256	0.6	1.1	2.1 b/	0.3 b/
		RANGE	49.2-108.7	11-15	1,400-1,800	7.7-7.9	2.7-8.1	[illegible]	8.2-11	4-6	1,300-1,550	[illegible]	4.4-21	240-263	[illegible]	[illegible]	-	-

a/ See Figure 1.
b/ [illegible]
c/ No flow on September [illegible], 1971.

TABLE D-7

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA AT SELECTED STATIONS ON THE CACHE LA POUDRE RIVER
DECEMBER 6-7, and 13-15, 1971

Map Key a/	Station Description		Flow CFS	Temp. °C	Cond. µmhos/cm	pH S.U.	Dissolved Oxygen		BOD mg/l	TOC mg/l	Alkalinity mg/l
							mg/l	% Sat.			
75	Cache la Poudre River (CLPR) near Mouth at Davis Range (RM 249.0/0.5)	AVERAGE	144	-	-	-	-	-	59		271
		RANGE	-	0.5-5.0	1,400-1,700	7.4-7.8	5.1-7.1	48-63	30-135		259-284
73	CLPR downstream from STP at Greeley (RM 249.0/5.2)	AVERAGE	132 (est)	-	-	-	9.1	-	29		253
		RANGE	-	0.0-3.5	1,050-1,700	7.6-7.9	8.2-9.6	72-81	22-38		249-257
72	CLPR at 6th Avenue in Greeley (RM 249.0/6.3)	AVERAGE	122 (est)	-	-	-	11.0	-	8.5		253
		RANGE	-	0.0-2.5	1,000-1,800	7.8-8.1	10.6-12.1	89-108	6-12		250-257
68	CLPR upstream of Eaton Draw (RM 249.0/7.0)	AVERAGE	111	-	-	-	11.1	91	4.8		247
		RANGE	-	0.0-2.5	1,300-1,725	7.5-8.0	10.6-12.7	89-96	3-10		242-252
69	Eaton Draw b/ at Mouth (RM 249.0/6.9/0.1)	AVERAGE	22.5	-	-	-	-	-	14	10	325
		RANGE	-	4.0-8.0	1,500-1,850	7.8-8.3	9.1-10.0	94-109	12-18	9.0-11.0	324-325
71	Eaton Draw upstream of Great Western (RM 249.0/6.9/7.2)	AVERAGE	1.8	-	-	-	9.4	-	3.4	8	348
		RANGE	1.71-2.07	2-7	1,400-1,520	8.0-8.3	8.3-10.5	75-100	2-6.6	5-10	341-355
70	Eaton Draw downstream from STP (RM 249.0/6.9/6.5)	AVERAGE	-	-	-	-	3.5	-	26	13	331
		RANGE	6.0 (est)	15-19	1,450-3,000	7.8-8.2	3.0-4.0	38-50	12-36	7-19	266-395

---

a/ See Figure 3.
b/ These stations sampled during the period November 30-December 4, 1971.

TABLE D-5

SUMMARY OF SELECTED STUDIES ON THE SOUTH PLATTE RIVER, WATERTON TO KERSEY, COLORADO
AUGUST 30-SEPTEMBER 16, 1971

Map Key a/	Station Description		Flow CFS	Temp °C	Cond. µmhos/cm	pH S.U.	Dissolved Oxygen mg/l	Dissolved Oxygen % Sat	BOD5 mg/l	TOC mg/l	Solids mg/l Total	Solids mg/l Susp	Turbidity J.T.U.	Alkalinity mg/l	mg/l as N NH3 - N	mg/l as N Kj - N	mg/l as N NO2 + NO3	Total P mg/l
1	South Platte River at Waterton Bridge east of Water Treatment Plant (RM 339.2)	AVERAGE	320	-	-	-	7.6	95.8	1.0	<1	250	21	-	108	0.2 b/	0.2 b/	0.11	0.1
		RANGE	291-345	15.0-20.0	330-540	7.3-8.7	7.3-8.2	84.0-100	0.7-1.3	<1-1	190-320	16-30	-	98-116	-	-	0.02-0.27	0.1-0.2
2	South Platte River at Blakeland Road (RM 336.5)	AVERAGE	-	-	-	-	8.2	102	1.0	-	216	18 b/	-	-	-	-	-	-
		RANGE	-	16.0-18.0	350-360	8.1-8.3	7.7-9.0	94-110	0.9-1.1	-	180-250	-	-	-	-	-	-	-
3	South Platte River at Colorado 470 Bridge (RM 334.9)	AVERAGE	-	-	-	-	7.7	98	1.5	-	283	23	-	99 c/	-	-	-	-
		RANGE	-	17.0-20.0	320-440	8.0-8.3	7.3-8.4	91-107	1.0-2.0	-	200-1,070	19-25	-	-	-	-	-	-
5	South Platte River at Bowles Avenue (RM 329.8)	AVERAGE	-	-	-	-	7.9	102	2.8	<1 b/	270	28	-	-	0.2	0.3	0.10	0.1
		RANGE	-	16.7-21.5	320-470	7.3-8.3	7.3-9.9	90-135	0.9-6.2	-	230-300	9-39	-	-	0.2-0.3	0.2-0.4	0.06-0.14	0.1-0.2
9	South Platte River at Florida Avenue (RM 323.2)	AVERAGE	-	-	-	-	7.0	93	5.1	<2	348	51	-	118	0.4	1.1	0.44	0.5
		RANGE	-	16.0-22.0	375-540	7.2-8.0	6.5-7.6	87-97	3.3-7.8	<1-3	270-410	21-120	-	110-124	0.2-0.8	0.5-2.1	0.42-0.47	0.4-0.5
10	South Platte River upstream of Cherry Creek (RM 317.8)	AVERAGE	-	-	-	-	7.0	96	5.1	-	404	57	-	121	-	-	-	-
		RANGE	-	17.0-24.0	360-675	7.7-8.6	5.0-8.5	70-114	3.0-6.7	-	300-570	38-150	-	115-127	-	-	-	-
12	South Platte River at 19th Street Bridge (RM 317.3)	AVERAGE	307	-	-	-	7.0	92	6.1	5	405	83	-	128	0.4	0.9	0.75	0.5
		RANGE	291-344	16.7-24.0	325-600	7.2-8.1	6.0-7.7	85-100	4.4-7.7	2-7	320-610	19-310	-	114-162	0.2-0.7	0.8-1.2	0.59-0.81	0.2-0.7
14	South Platte River at York Street (RM 313.4)	AVERAGE	-	-	-	-	6.9	90	7.4	<4	522	257	-	124	0.25	0.11	0.91	0.6
		RANGE	-	17.2-22.5	360-580	7.4-8.1	5.7-7.4	80-100	4.9-13	<1-9	100-1,100	38-700	-	112-148	0.2-0.3	0.8-1.3	0.87-0.98	0.5-0.8
24	South Platte River at 88th Avenue (RM 308.8)	AVERAGE	-	-	-	-	4.5	60	6.2 c/	-	692	280	-	156	-	-	-	-
		RANGE	-	18.0-22.0	640-800	7.3-7.6	3.3-5.7	45-75	-	-	510-1,280	62-810	-	133-180	-	-	-	-
25	South Platte River at Henderson, Colorado (RM 301.7)	AVERAGE	489	-	-	-	3.6	47	5.2	19	883	367	-	165	1.3	4.4	2.0	2.8
		RANGE	275-794	18.5-23.0	600-900	7.2-7.6	2.4-4.6	31-60	4.3-5.4	7-27	570-2,250	43-1,650	-	149-179	0.8-2.6	3.1-6.2	1.7-2.5	2.7-3.0
26	South Platte River at Brighton, Colorado (RM 296.1)	AVERAGE	-	-	-	-	3.7	49	8.1	-	616	213	-	161	-	-	-	-
		RANGE	-	18.5-24.0	620-990	7.3-7.8	3.0-4.6	39-63	5.6-13	-	490-750	13-880	-	152-171	-	-	-	-
29	South Platte River at Fort Lupton, Colorado (RM 288.2)	AVERAGE	738	-	-	-	3.8	51	5.2	13	707	182	-	160	0.7	4.3	3.0	2.8
		RANGE	630-895	18.5-23.5	750-1,050	7.3-7.6	3.2-4.1	45-56	4.3-6.2	7-25	550-1,090	40-640	-	137-169	0.2-1.5	2.8-6.0	2.5-3.7	[illegible]
33	South Platte River at Platteville, Colorado (RM 276.7)	AVERAGE	-	-	-	-	4.9	67	7	8 c/	732	108	-	163	-	-	-	-
		RANGE	-	18.7-25.0	650-1,010	7.4-8.0	4.0-6.5	55-85	5.4-9.6	-	630-800	33-220	-	148-173	-	-	-	-
31	South Platte River upstream of Mouth of St. Vrain Creek (RM 270.1)	AVERAGE	-	-	-	-	5.0	64	6.8	[illegible]	763	91	-	166	[illegible]	[illegible]	4.1	2.0
		RANGE	-	[illegible]-23.0	900-1,310	6.2-7.8	3.8-5.3	49-77	2.9-9.4	6-15	630-920	22-200	-	150-177	[illegible]	[illegible]	3.5-4.5	1.7-2.2
32	South Platte River downstream from St. Vrain Creek (RM 264.7)	AVERAGE	-	-	-	-	6.3	[illegible]	6.7	7	948	35	-	180	[illegible]	[illegible]	[illegible]	[illegible]
		RANGE	-	15.0-21.5	1,000-1,490	7.0-8.0	[illegible]	61-92	3.2-11	4-13	880-1,070	17-130	-	161-190	[illegible]	[illegible]	[illegible]	[illegible]

TABLE D-8 cont.

SUMMARY OF SELECTED STUDIES ON THE SOUTH PLATTE RIVER, WATERTON TO KERSEY, COLORADO

AUGUST 30-SEPTEMBER 16, 1971

Map Key[a]	Station Description		Flow CFS	Temp. °C	Cond. µmhos/cm	pH S.U.	Dissolved Oxygen		BOD$_5$ mg/l	TOC mg/l	Solids mg/l		Turbidity J.T.U	Alkalinity mg/l	mg/l as N			Total mg/l
							mg/l	% Sat.			Total	Susp.			NH$_3$ - N	KJ - N	NO$_2$ + NO$_3$	
46	South Platte River downstream from Big Thompson River between Evans and LaSalle at Highway U.S. 85 (RM 256.1)	AVERAGE	-	-	-	-	6.9	88	6.3	12	1,170	110	-	185	0.2[b]	0.8	3.9	1.0
		RANGE	-	18-22	1,100-1,700	6.8-8.1	5.6-7.5	65-95	3.1-12	4-23	990-1,290	40-190	-	174-193		0.6-0.9	3.7-4.1	0.6-1.3
58	South Platte River upstream of Cache la Poudre River near Evans (RM 252.5)	AVERAGE	-	-	-	-	8.1	87	2.0	<2	1,230	33	14	242	0.25	0.5	4.5	0.4
		RANGE	-	11-14	1,500-2,000	8.0-8.2	7.6-8.8	87-94	1.8-2.2	<1-2	1,150-1,280	22-50	10-17	227-254	0.2-0.3	0.4-0.6	4.4-4.6	0.3-0.5
59	South Platte River upstream of Mouth of Cache la Poudre River (RM 250.6)	AVERAGE	-	-	-	-	7.7	83	1.9	-	1,260	45	16	238	-	-	-	-
		RANGE	-	11-15	1,800-2,000	8.1-8.2	6.9-8.5	76-91	1.7-2.0	-	1,190-1,300	33-70	13-20	228-243	-	-	-	-
76	South Platte River at Kersey (RM 246.5)	AVERAGE	438	-	-	-	7.7	86	4.1	3[c]	1,290	48	17	243	0.3[c]	0.6	3.8	0.6
		RANGE	400-485	11-15	1,600-1,850	8.1-8.2	7.2-8.2	80-89	3.4-4.9	-	1,210-1,340	40-60	14-21	233-251	-	0.5-0.7	3.6-3.9	0.6-0.7

[a] See Figures 2 and 3.

[b] All values the same.

[c] One value.

TABLE D-9

SUMMARY OF ANALYTICAL RESULTS AND FIELD MEASUREMENTS FOR THE SOUTH PLATTE RIVER
19th Street to 88th Avenue
December 13-17, 1971

Map Key[a]	Station	Flow CFS Avg.	Temperature °C Range	pH S.U. Range	Cond. µmhos/cm Range	DO mg/l Range	DO mg/l Avg.	Percent Saturation Range	BOD mg/l Average	Total Solids mg/l Average	Susp. Solids mg/l Average
12	SPR at 19th Street (RM 317.3)	107	3-6	7.6-7.9	775-875	8.5-10.0	9.4	76-93	18	675	38
13	SPR at Denver Northside plant (RM 314.5)	135[b]	3-6	7.4-7.9	825-1,000	7.8-9.8	8.9	70-91	14	750	29
14	SPR at York Street (RM 313.2)	2[b]	3-5	7.7-7.8	750-1,000	7.8-9.4	8.7	68-86	9	755	29
15	Burlington Ditch at York Street	142[c]	3-5	7.5-7.8	850-1,000	7.7-9.6	8.8	69-91	14	725	35
M-10	Denver Metro effluent (RM 312.2)	153							44		
17	SPR at I-270 bridge (RM 312.0	160[b]	15-15	7.1-7.4	1,000-1,100	6.0-6.4	6.1	71-76	44	890	95
19	Clear Creek at York Street (RM 311.1/0.3)	54	0.5-2	7.7-8.0	825-1,000	9.2-10.5	9.8	77-89	15		45

TABLE D-9 (Continued)

SUMMARY OF ANALYTICAL RESULTS AND FIELD MEASUREMENTS FOR THE SOUTH PLATTE RIVER
19th Street to 88th Avenue
December 13-17, 1971

Map Key[a]	Station	Flow CFS Avg.	Temperature °C Range	pH S.U. Range	Cond. µmhos/cm Range	DO mg/l Range	DO mg/l Avg.	Percent Saturation Range	BOD mg/l Average	Total Solids mg/l Average	Susp. Solids mg/l Average
23	SPR at Colorado 224 (70th Avenue) (RM 310.9)	220[b]	8-9	7.3-7.6	950-1,050	7.4-8.0	7.8	77-83	40	820	65
24	SPR at 88th Avenue (RM 308.8)	200[b]	3-12	7.4-7.7	775-1,100	6.7-7.3	7.0	60-81			

---

a/ See **Figure** 2.
b/ Estimated flow.

TABLE D-10

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA AT SELECTED STATIONS ON THE SOUTH PLATTE RIVER
UPSTREAM OF BRIGHTON DOWNSTREAM TO KERSEY
DECEMBER 6-10, 1971

Map Key[a/]	Station Description		Flow CFS	Temp. °C	Cond. µmhos/cm	pH S.U.	Dissolved Oxygen mg/l	Dissolved Oxygen % Sat.	BOD mg/l	TOC mg/l	Alkalinity mg/l
25	South Platte River (SPR) at Henderson, Colorado (RM 301.7)	AVERAGE	200	FLOW MEASUREMENTS ONLY FROM USGS GAGE							
		RANGE	168-250								
26	SPR at Colorado 7 bridge west of Brighton, Colorado (RM 296.1)	AVERAGE		-	-	-	5.2		37	61	227
		RANGE		3.0-9.0	950-1,100	7.3-7.5	5.1-5.4		20-48	20-87	226-229
27	SPR downstream from STP at Brighton, Colorado (RM 295.7)	AVERAGE		-	-	-	4.8	-	39	66	234
		RANGE		2.0-9.0	1,100-1,200	7.3-7.5	4.5-5.0	41-49	14-67	25-94	232-236
28	SPR downstream from Great Western at Brighton, Colorado (RM 294.4)	AVERAGE		-	-	-	4.7	-	37	67	273
		RANGE		2.0-9.0	775-1,300	7.3-7.6	4.5-5.3	41-55	22-56	22-100	222-362
29	SPR at Fort Lupton, Colorado (RM 288.2)	AVERAGE	322	FLOW MEASUREMENTS ONLY FROM USGS GAGE							
		RANGE	307-339								
59	SPR one mile upstream of[b/] mouth of Cache la Poudre River (RM 250.6)	AVERAGE	670(est)	-	-	-	9.4	-	12	-	244
		RANGE		0.0-2.0	1,300-1,400	7.4-7.8	8.9-10.0	83-74	7.5-15	-	244-244
76	SPR at Kersey, Colorado[b/] (Colorado 37 bridge) (RM 246.5)	AVERAGE	842	-	-	-	8.3	-	26	-	254
		RANGE	806-887	0.0-2.5	1,300-1,500	7.5-7.8	7.7-9.1	61-72	16-36	-	209-300

[a/] See Figure 3.

[b/] These stations sampled December 6-7 and 13-15, 1971.

TABLE D-11

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA AT SELECTED STATIONS ON THE SOUTH PLATTE RIVER
UPSTREAM OF GREAT WESTERN SUGAR-FORT MORGAN DOWNSTREAM TO I-80 BRIDGE, NEBRASKA

Map Key[a]	Station Description	Date of Survey		Flow CFS	Temp. °C	Cond. µmhos/cm	pH S.U	Dissolved Oxygen mg/l	Dissolved Oxygen % Sat.	BOD mg/l	TOC mg/l	Alkalinity mg/l
88	South Platte River (SPR) downstream from Nebraska-Colorado state line (I-80 bridge) (RM 81.1)	11/29-12/3/71	AVERAGE		-	-	-	11.0	-	3.5	7	
			RANGE		.5-2.0	1,500-1,650	8.1	10.5-11.6	85-92	3.0-5.4	5-12	[illegible]-271
87	SPR at Julesburg (bridge on US 385) (RM 86.9)	11/29-12/3/71	AVERAGE	340	-	-	-	10.8	-	3.8	8	264
			RANGE	329-352	.5-2.5	1,500-1,650	8.0-8.2	10.4-11.4	82-93	3.0-5.4	5-11	254-271
86	SPR downstream from Ovid, Colorado (RM 94.0)	11/29-12/3/71	AVERAGE		-	-	-	9.9	-	13	10	264
			RANGE		2.0-4.0	1,550-1,600	7.6-8.1	9.5-10.0	82-87	10-23	8-13	262-275
84	SPR at Ovid, Colorado (bridge on Colorado 23) (RM 95.4)	11/29-12/3/71	AVERAGE		-	-	-	11.3	-	2.0	6	268
			RANGE		0.5-2.5	1,500-1,700	8.0-8.2	10.8-11.6	89-95	2.0-2.4	4-9	262-271
83	SPR downstream from Great Western discharge at Sterling, Colorado (RM 150.0)	11/29-12/3/71	AVERAGE		-	-	-	10.0	-	9.0	9	267
			RANGE		2.5-9.0	1,550-1,800	8.2-8.5	9.1-10.5	74-91	7.0-14	4-18	260-275
92	SPR upstream of Sterling, Colorado (RM 151.6)	11/29-12/3/71	AVERAGE		-	-	-	11.0	-	3.0	5	267
			RANGE		2.5-6.0	1,600-1,900	8.1-8.4	10.2-11.5	82-102	2.0-5.0	4-6	262-271

TABLE D-11 (Continued)

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA AT SELECTED STATIONS ON THE SOUTH PLATTE RIVER
UPSTREAM OF GREAT WESTERN SUGAR-FORT MORGAN DOWNSTREAM TO I-80 BRIDGE, NEBRASKA

Map Key[a/]	Station Description	Date of Survey		Flow CFS	Temp. °C	Cond. µmhos/cm	pH S.U.	Dissolved Oxygen		BOD mg/l	TOC mg/l	Alkalinity mg/l
								mg/l	% Sat.			
81	SPR at Balzac (RM 174.4)	11/29-12/3/71	AVERAGE	97	(FLOW ONLY - USGS GAGE)							
			RANGE	92-102								
80	SPR downstream from Great Western discharge at Fort Morgan, Colorado (RM 195.4)	11/29-12/3/71	AVERAGE		-	-	-	8.8	-	5.0	6	273
			RANGE		3.5-8.0	1,400-1,800	8.1-8.4	8.4-9.4	71-89	3.0-6.0	4-8	264-279
78	SPR upstream of Great Western discharge at Fort Morgan, Colorado (RM 196.6)	11/29/12/3/71	AVERAGE		-	-	-	11.0	-	2.0	6	273
			RANGE		1.0-5.0	1,500-1,750	8.1-8.3	9.8-11.5	85-99	2.0-3.0	4-8	264-279
77	SPR at Weldona (RM 203.9)	11/29-12/3/71	AVERAGE	288	(FLOW ONLY - USGS GAGE)							
			RANGE	273-292								

---

a/ See Figure 4.

TABLE D-12

SUMMARY OF HEAVY METAL ANALYSIS AT SELECTED STATIONS - SOUTH PLATTE RIVER BASIN

Map[a] Key	Station Description	Dates of Survey		Mercury µg/1	Cadmium mg/1	Chromium mg/1	Copper mg/1	Lead mg/1	Zinc mg/1
1	South Platte River at Waterton Bridge east of water treatment plant (RM 339.2)	August 30, 1971 September 2, 1971	AVERAGE	<.2	<.02	<.02	<.02	<.03	<.02
			RANGE	-	-	-	-	-	-
5	South Platte River at Bowles Avenue (RM 329.8)	August 30, 1971 September 2, 1971	AVERAGE	<.2	<.02	<.02	<.02	<.03	<.04
			RANGE	-	-	-	-	-	-
6	Bear Creek near Mouth (at Federal Blvd) (RM 326.4/0.7)	August 30, 1971 September 2, 1971	AVERAGE	<.2	<.02	<.02	<.02	.04	<.02
			RANGE	-	-	-	-	-	-
8	Bear Creek upstream of Morrison along Colorado 74 (second suspended walkway across the creek) (RM 326.4/13.0)	August 30, 1971 September 2, 1971	AVERAGE	<.2	<.02	<.02	<.02	<.03	<.02
			RANGE	-	-	-	-	-	-
9	South Platte River at Florida Avenue (RM 323.2)	August 30, 1971 September 2, 1971	AVERAGE	<.2	<.02[b]	<.02	<.02	<.03	<.02
			RANGE	<.2-.2	-	<.02-.02	<.02-.02	<.03-.03	<.02-.03

TABLE D-12 (Continued)

SUMMARY OF HEAVY METAL ANALYSIS AT SELECTED STATIONS - SOUTH PLATTE RIVER BASIN

Map Key[a]	Station Description	Dates of Survey		Mercury µg/l	Cadmium mg/l	Chromium mg/l	Copper mg/l	Lead mg/l	Zinc mg/l
11	Cherry Creek at Mouth (RM 317.7/0.1)	August 30, 1971 - September 2, 1971	AVERAGE	<.2	<.02	<.02	<.02	.03	.04
			RANGE	-	-	-	-	-	-
12	South Platte River at 19th Street Bridge (RM 317.3)	August 30, 1971 - September 2, 1971	AVERAGE	<.2	<.02	<.02	.02	<.03	.09
			RANGE	-	-	-	-	-	-
19	Clear Creek at York Street (RM 311.1/0.3)	August 30, 1971 - September 2, 1971	AVERAGE	<.2	<.02	<.02	.02	<.04	.04
			RANGE	-	-	<.02-.02	.02-.03	<.03-.04	.04-.05
22	Clear Creek upstream of Golden (RM 311.1/18.7)	August 30, 1971 - September 2, 1971	AVERAGE	<.2	<.02	<.02	.05	<.03	.36
			RANGE	-	-	-	-	-	-
25	South Platte River at Henderson, Colo. (RM 301.7)	August 30, 1971 - September 2, 1971	AVERAGE	0.3	<.02[b]	.04	.06	<.10	.18
			RANGE	-	-	.04-.05	.04-.08	<.03-.16	.07-.29
29	South Platte River at Fort Lupton, Colo. (RM 288.2)	August 30, 1971 - September 2, 1971	AVERAGE	.4	<.02[b]	.04[b]	.08	.05	.14
			RANGE	-	-	-	.06-.09	.03-.07	.10-.17
33	St. Vrain Creek upstream of Longmont (RM 270.0/26.6)	September 7-10, 1971	AVERAGE	<.6	<.02[b]	<.02[b]	<.02[b]	<.03[b]	<.02[b]
			RANGE	.2-.9	-	-	-	-	-

TABLE D-12 (Continued)

SUMMARY OF HEAVY METAL ANALYSIS AT SELECTED STATIONS - SOUTH PLATTE RIVER BASIN

Map Key a/	Station Description	Dates of Survey		Mercury µg/1	Cadmium mg/1	Chromium mg/1	Copper mg/1	Lead mg/1	Zinc mg/1
38	St. Vrain near Mouth (RM 270.0/1.3)	September 7-10, 1971	AVERAGE	<.6	<.02 b/	<.02 b/	<.02 b/	<.04	<.02
			RANGE	<.2-1.0	-	-	-	<.03-.04	<.02-.02
39	Boulder Creek upstream of Boulder State Highway 119 (RM 270.0/17.4/27.6)	September 7-10, 1971	AVERAGE	<.4	<.02 b/	<.02 b/	<.02 b/	<.03 b/	<.02 b/
			RANGE	<.2-.6	-	-	-	-	-
40	Boulder Creek downstream from Boulder at 55th Street (1/2 mile north of Valmont) (RM 270.0/17.4/21.0)	September 7-10, 1971	AVERAGE	.4	<.02 b/	<.02 b/	<.02	<.03 b/	<.03
			RANGE	.2-.7	-	-	<.02-.02	-	<.02-.04
43	Coal Creek upstream of Mouth (RM 270.0/17.4/7.9/1.0)	September 7-10, 1971	AVERAGE	<.5	<.02 b/	<.02 b/	<.02 b/	<.03	<.02 b/
			RANGE	<.2-.7	-	-	-	<.03-.03	-
46	South Platte River downstream from the Big Thompson River between Evans and LaSalle at Hwy US-85 (RM 256.1)	September 7-10, 1971	AVERAGE	<.5	<.02 b/	<.02 b/	<.04	.09	.10
			RANGE	<.2-.7	-	-	<.02-.07	.08-.10	.05-.16

TABLE D-12 (Continued)

SUMMARY OF HEAVY METAL ANALYSIS AT SELECTED STATIONS - SOUTH PLATTE RIVER BASIN

Map Key[a]	Station Description	Dates of Survey		Mercury µg/l	Cadmium mg/l	Chromium mg/l	Copper mg/l	Lead mg/l	Zinc mg/l
47	Big Thompson River west of Loveland on US 34 (third bridge) Fawn Hollow (RM 260.4/37.9)	September 7-10, 1971	AVERAGE	<.3	<.02[b]	<.02[b]	<.02[b]	<.03[b]	<.02[b]
			RANGE	<.2-.4	-	-	-	-	-
48	Big Thompson River two miles west of I-25 on Colo. 402 1/4 mile north on Road 9E	September 7-10, 1971	AVERAGE	<.5	<.02[b]	<.02[b]	<.02	<.04	<.02
			RANGE	<.2-.7	-	-	<.02-.02	<.03-.04	<.02-.02
52	Big Thompson River at Mouth (RM 260.4/0.9)	September 7-10, 1971	AVERAGE	1.0	<.02[b]	<.02[b]	<.02[b]	.06	.02[b]
			RANGE	.2-1.8	-	-	-	.05-.07	-
53	Big Thompson River south and west of Berthoud (RM 260.4/7.0/18.9)	September 7-10, 1971	AVERAGE	<.3	<.02[b]	<.02[b]	<.03	.06	.03
			RANGE	<.2-.4	-	-	<.02-.04	.03-.10	.02-.04
57	Little Thompson River at Mouth (RM 260.4/7.0/0.1)	September 7-10, 1971	AVERAGE	<.5	<.02[b]	<.02[b]	.04	.06	.03
			RANGE	<.2-.7	-	-	.02-.07	.03-.10	.02-.04
60	Cache la Poudre River upstream of Bellevue off Hwy 285 at Hwy 54E (RM 249.0/53.6)	September 13-16, 1971	AVERAGE	<.2[b]	<.02[b]	<.02[b]	<.02[b]	.03[b]	<.02[b]
			RANGE	-	-	-	-	-	-

TABLE D-12 (Continued)

SUMMARY OF HEAVY METAL ANALYSIS AT SELECTED STATIONS - SOUTH PLATTE RIVER BASIN

Map Key[a]	Station Description	Dates of Survey		Mercury µg/l	Cadmium mg/l	Chromium mg/l	Copper mg/l	Lead mg/l	Zinc mg/l
62	Cache la Poudre River at Prospect Avenue in Fort Collins (RM 249.0/41.2)	September 13-16, 1971	AVERAGE	<.2[b]	<.02[b]	<.02[b]	<.02[b]	<.04	<.02[b]
			RANGE	-	-	-	-	<.03-.04	-
63	Cache la Poudre River at Timnath Road (RM 249.0/36.3)	September 13-16, 1971	AVERAGE	<.2[b]	<.02[b]	<.02[b]	<.02[b]	<.04	<.02[b]
			RANGE	-	-	-	-	<.03-.04	-
65	Cache la Poudre River downstream from Windsor & south of Bracewell (RM 249.0/17.9)	September 13-16 1971	AVERAGE	<.2[b]	<.02[b]	<.02[b]	<.02[b]	<.03	<.02[b]
			RANGE	-	-	-	-	<.03-.03	-
69	Eaton Draw at Mouth (RM 249.0/6.9/0.1)	September 13-16, 1971	AVERAGE	<.2[b]	<.02[b]	<.02[b]	<.02[b]	<.04	<.02[b]
			RANGE	-	-	-	-	<.03-.04	-
75	Cache la Poudre River near Mouth at Davis Ranch (RM 249.0/0.5)	September 13-16, 1971	AVERAGE	<.2[b]	<.02[b]	<.02[b]	<.02[b]	<.04	<.02[b]
			RANGE	-	-	-	-	<.03-.04	-

---

a/ See Figures 2, 3, and 4.
b/ All values the same.

APPENDIX E

BACTERIOLOGICAL RESULTS

TABLE E-1
SUMMARY OF BACTERIOLOGICAL ANALYSES FOR STREAM SURVEYS AT SELECTED STATIONS ON THE MAJOR TRIBUTARIES IN THE DENVER METROPOLITAN AREA

Station Description	Dates	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococcus MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
Bear Creek upstream of Morrison, Colorado (river mile 326.4/13.0)	8/30, 31 9/2/71	39,000	20,000	10,000	1,400	720	380	4,000	1,200	580
Bear Creek near mouth at Federal Blvd (river mile 326.4/[illegible]7)	8/30, 31 9/2/71	14,000	9,100	4,200	460	330	250	880	550	390
Clear Creek upstream of Golden (river mile 311.1/18.7)	8/30 9/2/71	5,100	2,500	1,300	370	120	39	1,100	610	340
Clear Creek at McIntyre Street (river mile 311.1/14.1)	8/30 9/2/71	240,000	120,000	56,000	13,000	5,800	2,600	59,000	16,000	4,600
Clear Creek at York Street (river mile 311.1/0.3)	8/30, 31 9/2/71	89,000	51,000	30,000	2,000	640	310	3,800	1,800	680
Cherry Creek at mouth (river mile 317.7/0.1)	8/30, 31 (2) 9/2/71	120,000	33,000	7,200	3,000	780	180	5,400	1,900	650
Sand Creek at mouth (river mile 312.1/0.1)	8/31	160,000	110,000	80,000	10,000	8,800	7,800	26,000	11,000	4,500

No. in ( ) indicates number of samples collected that date.

TABLE E-2
SUMMARY OF BACTERIOLOGICAL ANALYSES FOR STREAM SURVEYS AT SELECTED
STATIONS IN THE ST. VRAIN CREEK, BIG THOMPSON RIVER
AND CACHE LA POUDRE RIVER BASIN

Station Description	Dates	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococcus MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
Boulder Creek upstream of Boulder, Colorado (river mile 270.0/17.4/27.6)	9/7, 9, 10/71	680	370	210	32	<19	<10	260	160	96
Boulder Creek downstream from Boulder, Colorado (river mile 270.0/17.4/19.9)	9/7, 9, 10/71	5,500	3,100	1,400	58	18	6	310	170	90
Boulder Creek downstream from mouth of Coal Creek (river mile 270.0/17.4/7.3)	9/7, 9, 10/71	15,000	2,300	480	820	150	37	6,500	4,500	3,300
Boulder Creek near mouth (river mile 270.0/17.4/1.9)	9/7, 9, 10/71	2,600	2,200	1,800	2,300	790	360	40,000	4,400	810
Coal Creek, inflow to Boulder Creek (river mile 270.0/17.4/7.9/1.0)	9/7, 9, 10/71	49,000	16,000	2,400	2,000	1,300	610	12,000	72,000	26,000
St. Vrain Creek upstream of Longmont, Colorado (river mile 270.0/26.6)	9/7, 9, 10/71	14,000	7,600	3,800	420	290	240	2,100	780	450
St. Vrain Creek downstream from Longmont, Colorado (river mile 270.0/20.8)	9/7, 9, 10/71	37,000	19,000	5,500	4,400	1,400	510	26,000	11,000	6,100
St. Vrain Creek near mouth (river mile 270.0/1.3)	9/7, 9, 10/71	38,000	13,000	3,600	1,600	510	54	7,400	5,500	3,100
Little Thompson River south and west of Berthoud (river mile 260.4/18.9)	9/7, 9, 10/71	>80,000	>8,900	2,300	10,000	3,500	1,700	6,100	5,200	4,600
Little Thompson River 0.5 miles east of I-25 (river mile 260.4/7.0/11.1	9/7, 9, 10/71	48,000	38,000	27,000	2,700	1,900	1,400	80,000	25,000	9,600
Little Thompson River at mouth (river mile 260.4/7.0/0.10)	9/7, 9, 10/71	48,000	41,000	35,000	3,500	2,300	1,300	22,000	14,000	6,100

TABLE E-2 (Continued)
SUMMARY OF BACTERIOLOGICAL ANALYSES FOR STREAM SURVEYS AT SELECTED STATIONS IN THE ST. VRAIN CREEK, BIG THOMPSON RIVER AND CACHE LA POUDRE RIVER BASIN

Station Description	Dates	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococcus MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
Big Thompson River upstream of Loveland, Colorado (river mile 260.4/37.9)	9/7, 9, 10/ 71	500	450	400	26	<15	<10	170	140	100
Big Thompson River 2 miles west of I-25 on Colorado Hwy 402, 1/4 mile north on Hwy 9E (river mile 260.4/23.5)	9/7, 9, 10/ 71	120,000	62,000	24,000	2,800	1,300	380	840	580	280
Big Thompson River near mouth (river mile 260.4/0.9)	9/7, 9, 10/ 71	41,000	18,000	4,900	4,300	2,600	1,400	7,900	6,900	5,300
Cache la Poudre River upstream of Bellvue, Colorado (river mile 249.0/53.6)	9/13, 14, 15/ 71	6,400	450	50	10	<10	9	100	65	30
Cache la Poudre River upstream of Ft. Collins, Colorado (river mile 249.0/46.8)	9/13, 14, 15/ 71	3,200	1,500	390	310	130	70	5,700	720	190
Cache la Poudre River downstream from Ft. Collins, Colorado (river mile 249.0/41.2)	9/13, 14, 15/ 71	15,000	14,000	13,000	290	150	60	29,000	5,900	2,200
Cache la Poudre River at Interstate Hwy 25 (river mile 249.0/36.3)	9/13, 14, 15/ 71	80,000	25,000	12,000	930	840	770	3,000	1,600	900
Cache la Poudre River upstream of Windsor, Colorado (river mile 249.0/26.5)	9/13, 14, 15/ 71	18,000	4,600	1,500	1,200	470	120	5,600	2,400	1,300
Cache la Poudre River downstream from Windsor, Colorado (river mile 249.0/17.9)	9/13, 14, 15/ 71	9,000	3,100	1,700	1,600	750	410	4,700	3,800	2,900

TABLE E-2 (Continued)
SUMMARY OF BACTERIOLOGICAL ANALYSES FOR STREAM SURVEYS AT SELECTED STATIONS IN THE ST. VRAIN CREEK, BIG THOMPSON RIVER AND CACHE LA POUDRE RIVER BASIN

Station Description	Dates	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococcus MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
Cache la Poudre River near Spanish Colony, Colorado (river mile 249.0/9.4)	9/13, 14, 15/71	11,000	9,600	8,000	890	640	520	3,400	1,100	440
Cache la Poudre River at 6th Avenue, Greeley, Colorado (river mile 249.0/6.3)	9/13, 14, 15/71	37,000	20,000	9,000	7,300	3,200	650	57,000	16,000	1,500
Cache la Poudre River downstream from Greeley, Colorado (river mile 249.0/5.2)	9/13, 14, 15/71	>80,000	38,000	9,000	5,400	2,500	780	32,000	20,000	12,000
Cache la Poudre River near mouth (river mile 249.0/0.50)	9/13, 14, 15/71	52,000	27,000	12,000	3,300	2,100	1,400	7,200	2,600	1,000

TABLE E-3
SUMMARY OF BACTERIOLOGICAL ANALYSES FOR STREAM SURVEYS AT SELECTED STATIONS IN THE SOUTH PLATTE RIVER BASIN

Station Description	Dates	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococcus MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
South Platte River at Waterton, Colorado (river mile 339.2)	8/30, 31, 9/2/ 71	890	580	460	45	<20	<10	360	280	210
South Platte River at Bowles Avenue, Littleton, Colorado (river mile 329.8)	8/30, 31, 9/2/ 71	90,000	12,000	3,100	480	280	140	580	470	350
South Platte River at 19th Street Bridge, Denver, Colorado (river mile 317.3)	8/30, 9/2 (2) 71	120,000	73,000	52,000	1,900	900	580	1,800	1,300	920
South Platte River at York Street, Denver, Colorado (river mile 313.4)	8/30, 31, 9/2/ 71	150,000	>100,000	>80,000	>60,000	>13,000	4,600	23,000	6,200	1,200
South Platte River at Henderson, Colorado (river mile 301.7)	8/31, 9/2 (2) 71	>800,000	>320,000	140,000	73,000	7,900	1,700	42,000	2,300	400
South Platte River at Fort Lupton, Colorado (river mile 288.2)	8/31, 9/2(2) 71	1,200,000	>540,000	>160,000	37,000	13,000	7,500	8,300	5,600	3,700
South Platte River at Platteville, Colorado (river mile 276.7)	8/31, 9/2(2) 71	>800,000	>460,000	300,000	10,000	4,700	1,600	5,400	3,600	2,700
South Platte River upstream of mouth of St. Vrain Creek (river mile 270.1)	9/7,9,10 71	200,000	>130,000	73,000	32,000	11,000	2,700	18,000	14,000	11,000
South Platte River downstream from mouth of St. Vrain Creek (river mile 264.7)	9/7,9,10 71	>800,000	>100,000	5,000	>6,000	>1,800	230	10,000	4,700	2,400

TABLE E-3 (Continued)
SUMMARY OF BACTERIOLOGICAL ANALYSES FOR STREAM SURVEYS AT SELECTED STATIONS IN THE SOUTH PLATTE RIVER BASIN

Station Description	Dates	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococcus MF Count/100 ml		
		Maximum	Log **Mean**	**Minimum**	**Maximum**	Log **Mean**	**Minimum**	**Maximum**	Log **Mean**	**Minimum**
South Platte River downstream from mouth of Big Thompson River (river mile 256.1)	9/7,9 (2) 71	>80,000	>34,000	21,000	20,000	2,400	480	7,500	2,900	1,200
South Platte River upstream of mouth of Cache la Poudre River (river mile 252.5)	9/13,14,15 71	25,000	18,000	15,000	900	450	220	3,400	2,400	1,300
South Platte River downstream from mouth of Cache la Poudre River (river mile 250.6)	9/13,14,15 71	22,000	18,000	16,000	1,000	620	250	2,800	1,800	1,500
South Platte River at Kersey, Colorado (river mile 246.5)	9/13,14,15 71	90,000	33,000	13,000	8,200	2,000	840	11,000	2,700	880

No. in ( ) indicates number of samples collected that date.

TABLE E-4
SUMMARY OF BACTERIOLOGICAL ANALYSES AT SELECTED STATIONS ON ST. VRAIN CREEK
December 6-10, 1971

Station Description	Map Key	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococcus MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
St. Vrain Creek upstream from Great Western at Longmont (river mile 270/22.5).	33	2,100	1,200	570	[illegible]	[illegible]	84	3,100	910	560
St. Vrain Creek downstream from Great Western at Longmont (river mile 270/20.6).	35	740,000	40,000	940	96,000	1,350	16	[illegible]	12,000	810

TABLE E-5
SUMMARY OF BACTERIOLOGICAL ANALYSES AT SELECTED STATIONS ON THE BIG AND LITTLE THOMPSON RIVERS
December 6-10, 1971

Station Description	Map Key	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococci MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
Big Thompson River upstream from Great Western at Loveland (river mile 260.4/23.5).	48	4,200	1,000	290	200	13	4	430	180	90
Big Thompson River downstream from Great Western at Loveland (river mile 260.4/21.0).	49	39,000	17,000	6,100	88	25	8	51,000	9,100	3,000
Little Thompson River upstream from Great Western at Johnstown (river mile 260.4/7.0/4.0).	55	15,000	3,000	700	800	360	160	2,200	1,300	660
Little Thompson River downstream from Great Western at Johnstown (river mile 260.4/7.0/1.15).	56	500,000	210,000	88,000	19,000	6,900	1,500	86,000	60,000	42,000

TABLE E-6
SUMMARY OF BACTERIOLOGICAL ANALYSES AT SELECTED STATIONS ON THE CACHE LA POUDRE RIVER
December 6-7 and 13-15, 1971

Station Description	Map Key	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococci MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
Cache la Poudre River upstream of Eaton Draw (river mile 249/7.0).	68	3,800	1,800	1,100	690	150	50	2,600	1,500	600
Eaton Draw upstream of Sugar factory (river mile 249/6.9/7.2).	71				6,000	920	180	58,000	16,000	4,200
Eaton Draw downstream from Eaton Waste Water Treatment Plant (river mile 249/6.9/6.5).	70				6,300	1,700	780	130,000	47,000	16,000
Eaton Draw at the Mouth (river mile 249/6.9/0.10).	69				720	500	360	16,000	6,800	2,900
Cache la Poudre River upstream at 6th Avenue (river mile 249/6.3).	72	3,700	1,900	660	650	220	120	3,900	1,900	1,100
Cache la Poudre River just downstream from Greeley Waste Water Treatment Plant, upstream of Great Western (river mile 249/2.9).	73	1,400,000	30,000	4,900	150,000	3,400	200	1,500,000	19,000	2,600
Cache la Poudre River just upstream of Mouth (river mile 249/0.5).	75	1,500,000	180,000	50,000	100,000	19,000	4,800	1,400,000	420,000	>100,000

TABLE E-7
SUMMARY OF BACTERIOLOGICAL ANALYSES AT SELECTED STATIONS
ON THE SOUTH PLATTE RIVER
November 17-21, 1971

Map Key[a]	Station	Total Coliform Count/100 ml		Fecal Coliform Count/100 ml		Fecal Streptococci Count/100 ml	
		Range	Log Mean	Range	Log Mean	Range	Log Mean
12	South Platte River at 19th St. bridge.	3,800->90,000	>11,000	170-4,000	490	160-27,000	1,600
13	South Platte River at Denver Northside plant.	3,000-440,000	15,000	310-2,600	620	330-39,000	2,100
14	South Platte River at York Street[b]	5,000-270,000	21,000	61-10,000	790	360-87,000	3,800
15	Burlington Ditch at York Street[b]	3,200-210,000	16,000	410-6,500	850	570-77,000	3,500
17	South Platte River at I-270 Bridge.	7,000-6,200,000	340,000	70-70,000	>7,000	150-160,000	14,000
24	South Platte River at Colorado 224.	7,100-5,400,000	200,000	160->60,000	>3,300	980-98,000	8,200
19	Clear Creek at York Street.	600-190,000	7,100	<10-5,300	<190	220-190,000	1,800
M-9	Denver Metro effluent.[c]	9,200-14,000,000	--	230-430,000	--	--	--

---

[a] See Figure 2 for location.

[b] Isolated salmonella at this station.

[c] Data from in-plant survey August 1-9, 1971.

TABLE E-8

SUMMARY OF BACTERIOLOGICAL ANALYSES AT SELECTED STATIONS ON THE SOUTH PLATTE RIVER FROM BRIGHTON DOWNSTREAM TO KERSEY

December 6-15, 1971

Station Description	Map Key	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococci MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
South Platte River at Colorado 7 West of Brighton (river mile 296.10).	26	2,000,000	>760,000	>80,000	64,000	31,000	15,000	17,300	22,000	9,300
South Platte River downstream from Brighton Waste Water Treatment Plant (river mile 295.7).	27	2,100,000	>910,000	>80,000	64,000	31,000	15,000	53,000	22,000	7,500
South Platte River downstream from Great Western at Brighton (river mile 294.4).	28	3,000,000	>1,100,000	>80,000	140,000	73,000	40,000	[illegible]	51,000	25,000
South Platte River upstream of the Mouth of Cache la Poudre River (river mile 250.6).	59	960,000	>140,000	48,000	16,000	4,300	830	[illegible]	11,000	4,800
South Platte River at Kersey (river mile 246.5).	[illegible]	1,000,000	>160,000	59,000	72,000	15,000	4,900	170,000	45,000	12,000

TABLE E-9

SUMMARY OF BACTERIOLOGICAL ANALYSES AT SELECTED STATIONS ON THE SOUTH PLATTE RIVER FROM UPSTREAM OF FT. MORGAN TO I-80 BRIDGE IN NEBRASKA

November 29 - December 3, 1971

Station Description	Map Key	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococci MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
South Platte River upstream of Great Western Discharge at Fort Morgan (river mile 197.00).	78	1,200	500	340	172	53	20	1,700	950	670
South Platte River downstream from Great Western Discharge at Fort Morgan (river mile 195.50).	80	6,900	4,800	3,000	160	56	20	1,800	980	670
South Platte River upstream of Sterling (river mile 151.6).	82	640	150	30	44	22	<10	190	150	130
South Platte River downstream from Great Western Discharges at Sterling (river mile 150.0).	83	1,500,000	>350,000	92,000	150	63	36	360,000	>31,000	780
South Platte River upstream of Ovid at Colorado 23 Bridge (river mile 95.4).	84	51,000	1,900	190	240	140	70	6,000	2,100	920
Liddle Ditch downstream from Lodgepole Creek at Overflow Structure (river mile 95.1).	85	39,000	20,000	2,700	1,400	980	760	5,900	4,900	3,900
South Platte River downstream from Ovid (river mile 94.0).	86	2,500,000	>1,400,000	580,000	910,000	290,000	160,000	6,400,000	>680,000	110,000
South Platte River at Julesburg (river mile 87.0)	87	1,800,000	790,000	400,000	210,000	93,000	45,000	>800,000	>150,000	15,000
South Platte River at I-80 (river mile 81.1).	88	1,600,000	610,000	370,000	1,000,000	120,000	40,000	>800,000	>150,000	36,000

F1

APPENDIX F

AQUATIC GROWTHS

TABLE F-1

AQUATIC GROWTHS FROM GLASS-SLIDE SUBSTRATES, CACHE LA POUDRE RIVER
TEN DAYS EXPOSURE, RECOVERED IN SEPTEMBER, 1971

Station (River Mile)	Chlorophyll A ($\mu g/in^2$)	Total Algae (cells/in^2)	Pinnate (Type)	Diatoms (cells/in^2)	Green Coccoid		Filamentous Blue Green		Slimes	
					(Type)	(cells/in^2)	(Type)	(cells/in^2)	(Type)	(filaments/in^2)
53.6	-0-	13,597,040	Navicula	195,440	Nannochloris	13,401,600	-	-	-	-
41.2	39	17,551,908	Navicula	2,462,544	Nannochloris	15,076,800	Oscillatoria	12,564	Sphaerotilus	25,128
36.3	9	2,268,760	Navicula	889,252	Nannochloris	1,379,508	-	-	-	-
26.5	14	11,852,040	Navicula Nitzchia	1,591,440	Nannochloris Crucigenia	10,260,600	-	-	-	-
17.9	27	49,018,213	Navicula Nitzchia	3,638,906	Nannochloris Protococcus	45,379,307	-	-	Sphaerotilus	171,242
9.4	24	14,548,183	Navicula Nitzchia	2,635,648	Nannochloris Scenedesmus Protococcus Euglena	11,912,535	-	-	-	-
0.5	33	95,731,918	Navicula Nitzchia	4,414,152	Nannochloris Protococcus Euglena Unknown	91,317,766	-	-	Sphaerotilus	775,361

TABLE F-2
AQUATIC GROWTHS FROM GLASS-SLIDE SUBSTRATES
SOUTH PLATTE RIVER BASIN, COLORADO
14-Day Exposure Recovered in November, 1971

Location	Station (River Mile)	Sphaerotilus (filaments/in^2)	Algae (cells/in^2)
St. Vrain			
Longmont	22.5	*	*
Longmont	20.6	4,048,400	1,256,400
Little Thompson			
Johnstown	4.0	*	*
Johnstown	1.15	7,147,520	69,800
Big Thompson			
Loveland	25.6	*	*
Loveland	21.0	*	7,398,800
Cache la Poudre River			
Greeley	7.0	218,125	3,839,000
Greeley	6.3	4,900	977,200
Greeley	2.9	355,040,000	13,960,000
Platte River			
Brighton	296.1	152,560	146,580
Brighton	295.7	678,000	544,440
Brighton	294.4	1,221,500	3,664,500
Ft. Morgan	196.6	34,900	104,700
Ft. Morgan	195.4	1,647,280	474,640

TABLE F-2 cont.
AQUATIC GROWTHS FROM GLASS-SLIDE SUBSTRATES
SOUTH PLATTE RIVER BASIN, COLORADO
14-Day Exposure Recovered in November, 1971

Location	Station (River Mile)	Sphaerotilus (filaments/in^2)	Algae (cells/in^2)
Platte River cont.			
Sterling	151.6	22,685	102,112
Sterling	150.0	2,326,667	2,792,000
Ovid	95.4	9,307	39,553
Ovid	94.0	314,100	889,950
Julesburg	87.0	100,512	122,848
Nebraska	81.1	41,800	446,720

APPENDIX G

BENTHOS

TABLE G-1
BENTHOS, BEAR CREEK, COLORADO, AUGUST 30, 1971
(Numbers per square foot)

	Station (River Miles)		
	13.0	5.9	0.7
ROUNDWORMS (NEMATA)			Q
AQUATIC EARTHWORMS (OLIGOCHAETA)	3	4	29
LEECHES (HIRUDINEA)			Q
SOWBUGS (ISOPODA)			
Asellus			Q
SCUDS (AMPHIPODA)		Q	
MAYFLIES (EPHEMEROPTERA)			
Pseudocloeon	Q		
Tricorythodes	12	Q	6
Baetis	129	558	12
Stenonema	7	1	
DRAGONFLIES (GOMPHIDAE)			Q
STONEFLIES (PLECOPTERA)			
Isogenus		1	
Isoperla	2	2	
Acroneuria		8	
Pteronarcella	1		
WATER SCAVENGER BEETLES (HYDROPHILIDAE)			Q
ELMID BEETLES (ELMIDAE)			1
Stenelmis	102	34	11
CADDISFLIES (TRICHOPTERA)		4	
Hydropsyche	338	384	38
Cheumatopsyche	17	137	6

TABLE G-1 cont.
BENTHOS, BEAR CREEK, COLORADO, AUGUST 30, 1971
(Numbers per square foot)

	Station (River Miles		
	13.0	5.9	0.7
CADDISFLIES (TRICHOPTERA) cont.			
Brachycentrus	6	Q	
Macronemum	Q		
Rhyacophila	3		
Agraylea	Q	Q	
BLACK FLIES (SIMULIIDAE)	11	41	
CRANE FLIES (TIPULIDAE)	1	Q	
HORSEFLIES (TABANIDAE)	Q	7	1
SNIPE FLIES (RHAGIONIDAE)			
Atherix	19	Q	1
MIDGES (ORTHOCLADIINAE)	15	445	446
POUCH SNAILS (PHYSIDAE)			
Physa		Q	Q
ROUNDWORMS (PARASITENGENOA)		1	
Number of kinds	19	21	16
Numbers per square foot	670	1,634	557

Q = Organisms collected qualitatively only; arbitrarily assigned a value of 1 for computing.

TABLE G-2
BENTHOS, CLEAR CREEK, COLORADO, AUGUST 30, 1971
(Numbers per square foot)

	Station (River Miles)		
	18.7	10.4	0.3
ROUNDWORMS (NEMATA)			1
SLUDGEWORMS (TUBIFICIDAE)	Q	477	11
LEECHES (HIRUDINEA)			Q
WATER FLEAS (CLADOCERA)			1
SOWBUGS (ISOPODA)			Q
SCUDS (AMPHIPODA)			Q
MAYFLIES (EPHEMEROPTERA)			
Pseudocloeon		Q	Q
Tricorythodes		Q	
Baetis	59	34	21
WATER BOATMEN (CORIXIDAE)			1
BEETLES (COLEOPTERA)	1		
CADDISFLIES (TRICHOPTERA)			
Hydropsyche	13	1	
Cheumatopsyche	21		
Ochrotrichia	1		
FLIES (DIPTERA)	2		
BLACK FLIES (SIMULIIDAE)		Q	20
SOLDIER FLIES (STRATIOMYIIDAE)		1	
SNIPE FLIES (RHAGIONIDAE)			
Atherix	9		

TABLE G-2 cont.
BENTHOS, CLEAR CREEK, COLORADO, AUGUST 30, 1971
(Numbers per square foot)

	Station (River Miles)		
	18.7	10.4	0.3
BLOODWORMS (CHIRONOMIDAE)	5		11
MIDGES (ORTHOCLADIINAE)		19	36
POUCH SNAILS (PHYSIDAE)			
Physa		Q	20
Lymnaea			Q
Number of kinds	9	9	14
Numbers per square foot	112	536	127

Q = Organisms collected qualitatively only; arbitrarily assigned a value of 1 for computing.

TABLE G-3
BENTHOS, BOULDER CREEK, COLORADO, SEPTEMBER 7, 1971
(Numbers per square foot)

	Station (River Miles)					
	27.6	20.8	19.9	14.2	7.3	1.9
FLATWORM (TURBELLARIA)					2	184
ROUNDWORMS (NEMATA)				2	4	2
SLUDGEWORMS (TUBIFICIDAE)		Q	86	103	11	33
LEECHES (HIRUDINEA)				4	5	
SOWBUGS (ISOPODA)				1	Q	
SCUDS (AMPHIPODA)			Q	Q	3	8
MAYFLIES (EPHEMEROPTERA)						
Ephemerella	22					
Pseudocloeon				156	55	
Tricorythodes	Q	2	7	11	17	167
Baetis	43			25	22	109
Choroterpes				7		
Heptagenia	57					
Cloeon				Q		
DAMSELFLIES (COENAGRIONIDAE)			Q			
DRAGONFLIES (GOMPHIDAE)						1
STONEFLIES (PLECOPTERA)						
Isogenus	3					
Acroneuria	3					
Pteronarcella	10					
Neophasganophora capitata	Q					
WATER BOATMEN (CORIXIDAE)					1	
BROAD-SHOULDERED WATER STRIDERS (VELIIDAE)						1

TABLE G-3 cont.
BENTHOS, BOULDER CREEK, COLORADO, SEPTEMBER 7, 1971
(Numbers per square foot)

	Station (River Miles)					
	27.6	20.8	19.9	14.2	7.3	1.9
WATER STRIDERS (GERRIDAE)						
Gerris						9
BEETLES (COLEOPTERA)		1				1
ELMID BEETLES (ELMIDAE)						
Stenelmis	15			2		
WATER SCAVENGER BEETLES (HYDROPHILIDAE)			9		1	
CADDISFLIES (TRICHOPTERA)						
Hydropsyche	498			29		
Cheumatopsyche						14
Brachycentrus	1					
Rhyacophila	1					
Lepidostoma	3					
MICROCADDISFLIES (HYDROPTILIDAE)						10
Agraylea			2		8	
BLACK FLIES (SIMULIIDAE)	31		2	145	213	5
BITING MIDGES (CERATOPOGONIDAE)		99				
SOLDIER FLIES (STRATIOMYIIDAE)						1
SNIPE FLIES (RHAGIONIDAE)						
Atherix	6					
MIDGES (ORTHOCLADIINAE)	1	91	181	72	130	1,000
MIDGES (TANYPODINAE)			9		9	14

TABLE G-3 cont.
BENTHOS, BOULDER CREEK, COLORADO, SEPTEMBER 7, 1971
(Numbers per square foot)

	Station (River Miles)					
	27.6	20.8	19.9	14.2	7.3	1.9
SNAILS AND LIMPETS (GASTROPODA)						
Ferrissia				1		
Physa			Q	Q	89	17
Gyraulus			1			1
CLAMS (PELECYPODA)						2
ROUNDWORMS (PARASITENGONA)	1					
Number of kinds	17	5	11	16	16	19
Numbers per square foot	688	194	284	561	563	1,571

Q = Organisms collected qualitatively only; arbitrarily assigned a value of 1 for computing.

TABLE G-4
BENTHOS, ST. VRAIN CREEK, COLORADO, SEPTEMBER 9, 1971
(Numbers per square foot)

	Station (River Miles)		
	26.6	14.6	1.3
FLATWORM (TURBELLARIA)	Q		
ROUNDWORMS (NEMATA)	Q	2	2
SLUDGEWORMS (TUBIFICIDAE)	16	34	35
MAYFLIES (EPHEMEROPTERA)			
Tricorythodes	36	6	2
Baetis	436	1	15
Choroterpes	Q		
Heptagenia	2	2	Q
Cloeon	Q		
DAMSELFLIES (COENAGRIONIDAE)		Q	Q
DAMSELFLIES (LESTIDAE)			
Lestes		1	
DRAGONFLIES (GOMPHIDAE)		1	Q
STONEFLIES (PLECOPTERA)			
Isogenus	Q		
Acroneuria	2		
Pteronarcella	2		1
WATER BOATMEN (CORIXIDAE)		Q	
BROAD-SHOULDERED WATER STRIDERS (VELIIDAE)	Q		
ELMID BEETLES (ELMIDAE)			
Stenelmis	10		
WATER SCAVENGER BEETLES (HYDROPHILIDAE)	Q		Q

TABLE G-4 cont.
BENTHOS, ST. VRAIN CREEK, COLORADO, SEPTEMBER 9, 1971
(Numbers per square foot)

	Station (River Miles)		
	26.6	14.6	1.3
CADDISFLIES (TRICHOPTERA)			
Hydropsyche	798	1	15
Cheumatopsyche	88		5
Helicopsyche	8		
Brachycentrus	2		
Macronemum	Q		
Glossosoma	6		Q
Agraylea		Q	
AQUATIC CATERPILLARS (LEPIDOPTERA)			
Elophila	2		
BLACK FLIES (SIMULIIDAE)		3	9
CRANE FLIES (TIPULIDAE)	Q		
HORSEFLIES (TABANIDAE)	2		5
SNIPE FLIES (RHAGIONIDAE)			
Atherix	2		
MIDGES (ORTHOCLADIINAE)	438	339	86
MIDGES (TANYPODINAE)	14	4	2
SNAILS AND LIMPETS (GASTROPODA)			
Physa	8	12	Q
Gyraulus	26		

TABLE G-4 cont.
BENTHOS, ST. VRAIN CREEK, COLORADO, SEPTEMBER 9, 1971
(Numbers per square foot)

	Station (River Miles)		
	26.6	14.6	1.3
ROUNDWORMS (PARASITENGONA)	2		
Number of kinds	29	15	17
Numbers per square foot	1,909	409	183

Q - Organisms collected qualitatively only; arbitrarily assigned a value of 1 for computing.

TABLE G-5
BENTHOS, ST. VRAIN CREEK, COLORADO, NOVEMBER 29, 1971
(Numbers per square foot)

	Station (River Miles)	
	22.5	20.6
AQUATIC EARTHWORMS (OLIGOCHAETA)		3
MAYFLIES (EPHEMEROPTERA)		
Pseudocloeon	60	
Tricorythodes	146	Q
Baetis	1	
DAMSELFLIES (COENACRIONIDAE)	2	
BEETLES (COLEOPTERA)	2	
WATER SCAVENGER BEETLES (HYDROPHILIDAE)	Q	1
CADDISFLIES (TRICHOPTERA)		
Cheumatopsyche	4	
Agraylea	2	
BLACK FLIES (SIMULIIDAE)		
Simulium	1	
BITING MIDGES (CERATOPOGONIDAE)		23
CRANE FLIES (TIPULIDAE)	2	
BLOODWORMS (CHIRONOMIDAE)	103	4
SNAILS AND LIMPETS (GASTROPODA)		
Physa	Q	1
Number of kinds	12	6
Numbers per square foot	325	33

Q = Organisms collected qualitatively only; arbitrarily assigned a value of 1 for computing.

TABLE G-6
BENTHOS, LITTLE THOMPSON RIVER, COLORADO, SEPTEMBER 8, 1971
(Numbers per square foot)

	Station (River Miles)	
	11.1	0.1
SLUDGEWORMS (TUBIFICIDAE)	6	204
SCUDS (AMPHIPODA)		Q
MAYFLIES (EPHEMEROPTERA)		
Baetis		1
Heptagenia	1	
DRAGONFLIES (ANISOPTERA)		
Ophiogomphus	86	
Hetaerina	Q	
WATER SCAVENGER BEETLES (HYDROPHILIDAE)	Q	Q
CADDISFLIES (TRICHOPTERA)		
Hydropsyche	2	
Agraylea	13	
BLACK FLIES (SIMULIIDAE)	108	89
BITING MIDGES (CERATOPOGONIDAE)		Q
HORSEFLIES (TABANIDAE)		Q
MIDGES (ORTHOCLADIINAE)		131
MIDGES (TANYPODINAE)	10	2
SNAILS AND LIMPETS (GASTROPODA)		
Physa	2	Q
Lymnaea		1
Number of kinds	11	11
Numbers per square foot	231	433

Q = Organisms collected qualitatively only; arbitrarily assigned a value of 1 for computing.

TABLE G-7
BENTHOS, LITTLE THOMPSON RIVER, COLORADO, NOVEMBER 29, 1971
(Numbers per square foot)

	Station (River Miles)	
	4.0	1.15
AQUATIC EARTHWORMS (OLIGOCHAETA)		Q
SCUDS (AMPHIPODA)		
Gammarus	1	
DAMSELFLIES (COENAGRIONIDAE)	Q	
STONEFLIES (AGRIONIDAE)	Q	
DAMSELFLIES (NEMOURIDAE)		
Perlomyia	Q	
ELMID BEETLES (ELMIDAE)		
Stenelmis		1
BLACK FLIES (SIMULIIDAE)		
Simulium	2	
BLOODWORMS (CHIRONOMIDAE)	4	2
CRANE FLIES (TIPULIDAE)	Q	
SNAILS AND LIMPETS (GASTROPODA)		
Physa	Q	1
CLAMS (PELECYPODA)		1
Number of kinds	8	5
Numbers per square foot	12	6

Q = Organisms collected qualitatively; arbitrarily assigned a value of 1 for computing.

TABLE G-8
BENTHOS, BIG THOMPSON RIVER, COLORADO, SEPTEMBER 8, 1971
(Numbers per square foot)

	Station (River Miles)				
	37.9	23.5	16.5	8.2	0.9
HYDROIDS (COELENTERATA)	Q				
ROUNDWORMS (NEMATA)				1	
SLUDGEWORMS (TUBIFICIDAE)	Q	52	50	33	102
LEECHES (HIRUDINEA)		1	Q		
SOWBUGS (ISOPODA)		Q			
SCUDS (AMPHIPODA)					
Hyalella azteca		1	Q	4	Q
CRAYFISH (CAMBARINAE)		Q		Q	
MAYFLIES (EPHEMEROPTERA)					
Ephemerella	Q	Q			
Pseudocloeon	15	139	270	32	4
Tricorythodes	Q	8	542	7	Q
Baetis	15	13	18	Q	Q
Heptagenia	3		Q	Q	Q
Paraleptophlebia	Q				
DAMSELFLIES (COENAGRIONIDAE)			Q	Q	Q
DRAGONFLIES (ANISOPTERA)					
Ophiogomphus	1				
DRAGONFLIES (AESCHNIDAE)		Q			
STONEFLIES (PLECOPTERA)					
Isoperla	1				
Acroneuria	4				
Pteronarcella	1				

TABLE G-8 cont.
BENTHOS, BIG THOMPSON RIVER, COLORADO, SEPTEMBER 8, 1971
(Numbers per square foot)

	Station (River Miles)				
	37.9	23.5	16.5	8.2	0.9
WATER BOATMEN (CORIXIDAE)		Q	Q		
WATER STRIDERS (GERRIDAE)			Q		
BEETLES (COLEOPTERA)	2				
ELMID BEETLES (ELMIDAE)					
Stenelmis	2	Q			
PREDACEOUS DIVING BEETLES (DYTISCIDAE)					
Hydrocanthus			Q		
CADDISFLIES (TRICHOPTERA)					
Hydropsyche	32	25	2		
Cheumatopsyche	1	1	14		
Brachycentrus	6				
Macronemum		Q		Q	
Glossosoma	1				
MICROCADDISFLIES (HYDROPTILIDAE)			18		
Agraylea		4			
BLACK FLIES (SIMULIIDAE)	35	5	24	203	278
BITING MIDGES (CERATOPOGONIDAE)					Q
CRANE FLIES (TIPULIDAE)	Q				
HORSEFLIES (TABANIDAE)		Q			
SNIPE FLIES (RHAGIONIDAE)					
Atherix		Q			

TABLE G-8 cont.
BENTHOS, BIG THOMPSON RIVER, COLORADO, SEPTEMBER 7, 1971
(Numbers per square foot)

	Station (River Miles)				
	37.9	23.5	16.5	8.2	0.9
MIDGES (ORTHOCLADIINAE)	34	270	462	106	418
MIDGES (TANYPODINAE)		Q	4	1	
SNAILS AND LIMPETS (GASTROPODA)					
Physa		Q	Q	Q	
CLAMS (PELECYPODA)	1				
Number of kinds	22	22	18	14	10
Numbers per square foot	160	530	1,412	393	808

Q = Organisms collected qualitatively only; arbitrarily assigned a value of 1 for computing.

TABLE G-9
BENTHOS, BIG THOMPSON RIVER, COLORADO, NOVEMBER 29, 1971
(Numbers per square foot)

	Station (River Miles)	
	25.6	23.5
AQUATIC EARTHWORMS (OLIGOCHAETA)	5	504
SCUDS (AMPHIPODA)		
Gammarus	Q	2
MAYFLIES (EPHEMEROPTERA)		
Pseudocloeon	1	
Stenonema	Q	
STONEFLIES (PLECOPTERA)		
Isoperla	2	
Perlomyia	Q	
WATER BOATMEN (CORIXIDAE)	Q	
AQUATIC CATERPILLARS (LEPIDOPTERA)		
Elophila	1	
BEETLES (COLEOPTERA)	8	
ELMID BEETLES (ELMIDAE)		
Stenelmis	7	
CADDISFLIES (TRICHOPTERA)		
Agraylea	5	
Hydropsyche	93	244
Cheumatopsyche	8	
Brachycentrus	1	2
Pychopsyche	Q	

TABLE G-9 cont.
BENTHOS, BIG THOMPSON RIVER, COLORADO NOVEMBER 29, 1971
(Numbers per square foot)

	Station (River Miles)	
	25.6	23.5
BLOODWORMS (CHIRONOMIDAE)	68	36
BLACK FLIES (SIMULIIDAE)		
Simulium	1	
BITING MIDGES (CERATOPOGONIDAE)		10
HORSEFLIES (TABANIDAE)	Q	
CRANE FLIES (TIPULIDAE)	7	
SNIPE FLIES (RHAGIONIDAE)		
Atherix	8	
CRANEFLIES (LIMONIINAE)		
Antocha	6	
SNAILS AND LIMPETS (GASTROPODA)		
Physa	Q	Q
Number of kinds	22	7
Numbers per square foot	228	799

Q = Organisms collected qualitatively; arbitrarily assigned a value of 1 for computing.

TABLE G-10
BENTHOS, CACHE LA POUDRE RIVER, COLORADO, SEPTEMBER 13, 1971
(Numbers per square foot)

	Station (River Miles)						
	53.6	41.2	36.3	26.5	17.9	9.4	0.5
FLATWORM (TURBELLARIA)	Q			Q		Q	
ROUNDWORMS (NEMATA)		6		24			
SLUDGEWORMS (TUBIFICIDAE)		64	16	24	492	21	22,810
LEECHES (HIRUDINEA)		Q	4	2			
SOWBUGS (ISOPODA)	Q		Q	Q	4	Q	10
SCUDS (AMPHIPODA)			Q	Q	Q	Q	
CRAYFISH (DECAPODA)							
Orconectes					1		
MAYFLIES (EPHEMEROPTERA)							
Pseudocloeon	5	46	4	34	6		
Tricorythodes		132	118	126	10	Q	
Baetis			Q	2			
Heptagenia	9	Q	Q	Q	2	Q	
Rithrogenia	25						
Cloeon			Q			Q	
Paraleptophlebia	6	Q					
DAMSELFLIES (COENAGRIONIDAE)		Q					
DRAGONFLIES (GOMPHIDAE)					1		

TABLE G-10 cont.
BENTHOS, CACHE LA POUDRE RIVER, COLORADO, SEPTEMBER 13, 1971
(Numbers per square foot)

	Station (River Miles)						
	53.6	41.2	36.3	26.5	17.9	9.4	0.5
STONEFLIES (PLECOPTERA)							
Isogenus	3						
Pteronarcys	5						
Alloperla	2						
WATER BOATMEN (CORIXIDAE)			Q		Q	Q	
BROAD-SHOULDERED WATER STRIDERS (VELIIDAE)				Q			
BEETLES (COLEOPTERA)		2					
ELMID BEETLES (ELMIDAE)							
Stenelmis	8	Q					
PREDACEOUS DIVING BEETLES (DYTISCIDAE)						Q	
CADDISFLIES (TRICHOPTERA)							
Hydropsyche	81		6	116		2	
Cheumatopsyche	3	4		224			
Brachycentrus	193		10	2			
Macronemum			56				
Glossosoma	24						
Lepidostoma	1						
Agraylea				6	6		
BLACK FLIES (SIMULIIDAE)	3		108	5,918	112	15	
BITING MIDGES (CERATOPOGONIDAE)		Q					

TABLE G-10 cont.
BENTHOS, CACHE LA POUDRE RIVER, COLORADO, SEPTEMBER 13, 1971
(Numbers per square foot)

	Station (River Miles)						
	53.6	41.2	36.3	26.5	17.9	9.4	0.5
SNIPE FLIES (RHAGIONIDAE)							
Atherix	2	Q					
HORSEFLIES (TABANIDAE)					Q		
BLOODWORMS (CHIRONOMIDAE)			1,054				
MIDGES (ORTHOCLADIINAE)	11	958		228	546	786	460
MIDGES (TANYPODINAE)				12			
SNAILS AND LIMPETS (GASTROPODA)							
Ferrissia		Q	18		14		
Physa			2	Q	34	Q	Q
Number of kinds	19	15	17	19	16	13	4
Numbers per square foot	394	1,220	1,420	6,724	1,232	833	23,281

Q = Organisms collected qualitatively only; arbitrarily assigned a value of 1 for computing.

TABLE G-11
BENTHOS, CACHE LA POUDRE RIVER, COLORADO, NOVEMBER 30, 1971
(Numbers per square foot)

	Station (River Miles)		
	7.0	6.3	2.9
AQUATIC EARTHWORMS (OLIGOCHAETA)	318	148	531
WATER FLEAS (CLADOCERA)			2
MAYFLIES (EPHEMEROPTERA)			
Pseudocloeon			1
WATER BOATMEN (CORIXIDAE)	1		
CADDISFLIES (TRICHOPTERA)			
Agraylea		Q	
BLOODWORMS (CHIRONOMIDAE)	182	4	16
BLACK FLIES (SIMULIIDAE)			
Simulium	50	5	4
SNAILS AND LIMPETS (GASTROPODA)			
Physa	28	2	—
Number of kinds	5	5	5
Numbers per square foot	579	160	554

Q = Organisms collected qualitatively; arbitrarily assigned a value of 1 for computing.

TABLE G-12
BENTHOS, SOUTH PLATTE RIVER AND SELECTED TRIBUTARIES, COLORADO
(Numbers per square foot)
Collected in August, September and October, 1971

	Station (River Miles)																		
	339.2	336.5	334.9	332.3	329.8	323.2	317.8	317.7/0.1	317.3	313.4	312.1/0.1	308.8	301.7	296.1	288.2	276.7	264.7	252.5	246.5
FLATWORM(TURBELLARIA)								Q				Q			Q				
ROUNDWORMS (NEMATA)		Q	4		1														
AQUATIC EARTHWORMS (OLIGOCHAETA)			6	2	8	8	70	43	151	96	1,060	678	1,316	2,228	3,180	232	2	10	23
LEECHES (HIRUDINEA)						Q	Q	Q	Q	Q					Q				
SCUDS (AMPHIPODA)						Q									Q				Q
SPRINGTAILS (SMINTHURIDAE)																Q			
MAYFLIES (EPHEMEROPTERA)																			
Ephemerella				0															
Pseudocloeon	4	3			Q	Q		1										10	
Tricorythodes	1	3	101	Q	1	5	1		13	Q	Q		Q		1		Q		Q
Cinygmula	3																		
Baetis	7	9	7	1	1	1	2		14			3	1				Q		
Caenis		2																	
Heptagenia			6	1	Q	1			Q							Q			
Rithrogenia		Q																	
Iron		2																	
Ironodes	1																		
Stenonema	2	2																	
Cloeon															Q				

TABLE G-12 (Continued)
BENTHOS, SOUTH PLATTE RIVER AND SELECTED TRIBUTARIES, COLORADO
(Numbers per square foot)
(Collected in August, September and October, 1972)

	Station (River Miles)																		
	339.1	336.5	335.5	332.5	329.8	321.2	317.8	317.2/0.1	317.3	313.4	312.1/0.2	308.8	301.7	296.1	[illegible]	275.1	266.7	253.5	246.5
MAYFLIES (LEPTOPHLEBIIDAE)			0			1													
Choroterpes		0	2																
DAMSELFLIES (ZYGOPTERA)								1							0				
DAMSELFLIES (COENAGRIONIDAE)									0						0				
DRAGONFLIES (GOMPHIDAE)		0				1	2		1	2									
STONEFLIES (PLECOPTERA)																			
Isogenus		0																	
Isoperla	1		1	0															
Acroneuria		1																	
Pteronarcys		0		0															
BUGS (HEMIPTERA)	1																		
WATER BOATMEN (CORIXIDAE)																			
BEETLES (COLEOPTERA)						1									0				
WATER SCAVENGER BEETLES (HYDROPHILIDAE)																1			
CRAWLING WATER BEETLES (HALIPLIDAE)																0			
Brychius															0		0		

TABLE G-12 (Continued)
BENTHOS, SOUTH PLATTE RIVER AND SELECTED TRIBUTARIES, COLORADO
(Numbers per square foot)
Collected in August, September and October, 1971

	Station (River Miles)																		
	339.2	336.5	334.9	332.3	329.8	323.2	317.8	317.7/0.1	317.3	313.4	312.1/0.1	308.8	301.7	296.1	288.2	276.7	264.7	252.5	246.5
CADDISFLIES (TRICHOPTERA)																			
Hydropsyche	1	21	7	Q	Q	2								1			Q	2	
Cheumatopsyche		29	5									1							
Glossosoma																	3		Q
Agraylea									3	2		6		2					
Rhyacophila		1																	
Brachycentrus								1											
BLOODWORMS (CHIRONOMIDAE)	7	145																	
MIDGES (ORTHOCLADIINAE)			178	2	8	20	14	125	86	152	384	39	105	54	73	108	23	34	22
MIDGES (TANYPODINAE)							2		3		20								
BLACK FLIES (SIMULIIDAE)	5	Q		Q												Q	3	17	9
BITING MIDGES (CERATOPOGONIDAE)						3	2												
HORSEFLIES (TABANIDAE)	Q		Q		Q		1									1			
CRANE FLIES (TIPULIDAE		1																	
SOLDIER FLIES (STRATIOMYIIDAE)			1																

TABLE [illegible] (Continued)
BENTHOS, SOUTH PLATTE RIVER AND SELECTED TRIBUTARIES, COLORADO
(Numbers per Square Foot)
Collected in August, September and October, [illegible]

	Station (River Miles)																		
	[illegible]	136.5	[illegible]	[illegible]	[illegible]	[illegible]	117.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	132.5	[illegible]
ANTHOMYIIDS (ANTHOMYIIDAE)																			
Limnophora																	[illegible]	41	
SHORE FLIES (EPHYDRIDAE)																		[illegible]	
SNIPE FLIES (RHAGIONIDAE)																			
Atherix	1	1		1							Q								
SNAILS AND LIMPETS (GASTROPODA)																			
Ferrissia									1										
Physa	Q					1	[illegible]	2	12	46	28	2	1	8	1	[illegible]	8		
Lymnaea						1													
Number of kinds	15	21	14	11	10	11	10	8	13	7	8	8	6	7	11	[illegible]	12	8	7
Numbers per square foot	37	229	337	13	24	48	96	175	288	299	1,494	732	1,424	2,292	1,268	409	69	74	58

Q = Organisms collected qualitatively only; arbitrarily assigned a value of 1 for computing.

TABLE G-13
BENTHOS, SOUTH PLATTE RIVER, COLORADO
(Numbers per square foot)
Collected November 29 and 30, 1971

	Station (River Miles)														
	296.1	295.7	294.4	264.7	252.5	250.6	246.5	196.6	195.4	151.6	150.0	95.4	94.0	87.0	81.1
FLATWORM (TURBELLARIA)		Q													
ROUNDWORMS (NEMATA)					5							5	1		
SLUDGEWORMS (TUBIFICIDAE)	213	64	128	1,864	566	7,088	8,776	1	213	752	6		67		4,916
LEECHES (HIRUDINEA)	Q		Q												
WATER FLIES (CLADOCERA)	3														
SCUDS (AMPHIPODA)															
Gammarus	Q	Q	Q		Q					Q		Q	Q	Q	Q
MAYFLIES (EPHEMEROPTERA)															
Pseudocloeon					1	20		Q		1		Q			8
Tricorythodes							Q	Q				Q	Q		8
Baetis															4
DAMSELFLIES (COENAGRIONIDAE)	Q												Q	Q	
STONEFLIES (AGRIONIDAE)													Q		
DRAGONFLIES (GOMPHIDAE)												Q			
WATER SCAVENGER BEETLES (HYDROPHILIDAE)								Q							
PREDACEOUS DIVING BEETLES (DYTISCIDAE)								Q							4

TABLE G-13 (Cont)
BENTHOS, SOUTH PLATTE RIVER, COLORADO
(Numbers per square foot)
Collected November 29 and 30, 1971

	Station (River Miles)														
	296.1	295.7	294.4	264.2	252.5	250.6	246.5	196.6	195.4	151.6	150.0	95.4	94.0	87.0	81.1
CADDISFLIES (TRICHOPTERA)															
Hydropsyche					Q	12		Q	1	Q	1		Q	Q	8
Cheumatopsyche														Q	
Agraylea												2		Q	Q
BLACK FLIES (SIMULIIDAE)															
Simulium	Q				3	228		Q	4	20	12	4	15	1	556
BITING MIDGES (CERATOPOGONIDAE)		4	14	4	3	4	8		7						
ANTHOMYIID FLIES (ANTHOMYIIDAE)															
Limnophora					Q										
CRANE FLIES (TIPULIDAE)													1		
BLOODWORMS (CHIRONOMIDAE)	2	Q	3	13	51	489	88	Q	32	20	11	24	26	5	400
SNAILS AND LIMPETS															
Physa	Q		Q		1	4	8	Q			Q				Q
Number of kinds	8	5	7	3	10	7	5	9	5	6	5	8	10	7	11
Numbers per square foot	223	71	148	1,881	633	7,845	8,882	9	257	795	31	39	117	11	5,907

Q = Organisms collected qualitatively; arbitrarily assigned a value of 1 for computing.

APPENDIX H

FISH

TABLE H-1
FISH CAPTURED PER UNIT OF EFFORT
BEAR CREEK, COLORADO
September, 1971[a]

Species	Station (River Mile)			
	13.0		0.7	
	No.	Wt.[b]	No.	Wt.[b]
GAME FISH				
Rainbow trout	7	807		
FORAGE FISH				
Longnose dace			46	250
Creek chub			64	402
Longnose sucker	37	1,310	24	60
White sucker	6	578	—	—
TOTAL	50	2,695	134	712

[a] Unit of effort: electroshocked 200 feet.

[b] Weight in grams.

TABLE H-2
FISH CAPTURED PER UNIT OF EFFORT
CLEAR CREEK, COLORADO
September, 1971[a]

Species	Station (River Mile)			
	0.3		18.7	
	No.	Wt.[b]	No.	Wt.[b]
GAME FISH				
Brown trout			1	399
FORAGE FISH				
Creek chub	1	23		
Longnose sucker	5	433	6	322
White sucker	14	2,166		
Green sunfish	2	5		
TOTAL	22	2,627	7	661

---

[a] Unit of effort: electroshocked 200 feet.

[b] Weight in grams.

TABLE H-3
FISH CAPTURED PER UNIT OF EFFORT
BOULDER CREEK, COLORADO
September, 1971[a]

Species	Station (River Mile)			
	1.9		27.6	
	No.	Wt.[b]	No.	Wt.[b]
GAME FISH				
Rainbow trout			22	1,323
Smallmouth bass	1	340		
FORAGE FISH				
Gizzard shad	1	5		
River shiner	62	75		
Fathead minnow	5	-		
Longnose dace	6	11	1	8
Creek chub	6	70		
Longnose sucker			4	733
White sucker	115	4,420		
Plains killifish	1	-		
Green sunfish	3	50		
ROUGH FISH				
Carp	22	12,520		
TOTAL	222	17,491	27	2,064

[a] Unit of effort: electroshocked 200 feet.

[b] Weight in grams.

TABLE H-4
FISH CAPTURED PER UNIT OF EFFORT
ST. VRAIN CREEK, COLORADO
September, 1971[a]

Species	Station (River Mile)			
	1.3		26.6	
	No.	Wt.[b]	No.	Wt.[b]
GAME FISH				
Brown trout			7	162
Largemouth bass			4	20
FORAGE FISH				
Gizzard shad	12	82		
Brassy minnow	1	-		
River Shiner			18	140
Fathead minnow	49	425	120	338
Longnose dace			68	248
Creek chub			108	1,178
Longnose sucker			10	192
White sucker	1	20	10	441
Plains killifish			1	2
Green sunfish	5	81		
Johnny darter			1	1
ROUGH FISH				
Carp	25	5,415		
TOTAL	93	6,023	347	2,722

---

[a] Unit of effort: electroshocked 200 feet.

[b] Weight in grams.

TABLE H-5
FISH CAPTURED PER UNIT OF EFFORT
BIG THOMPSON RIVER, COLORADO[a]
September, 1971

Species	Station (River Mile)			
	0.9		37.9	
	No.	Wt.[b]	No.	Wt.[b]
GAME FISH				
Rainbow trout			1	8
FORAGE FISH				
Longnose dace	1	8	15	90
Creek chub	3	10		
Longnose sucker			15	1,474
White sucker	137	1,670	___	___
TOTAL	141	1,688	31	1,572

---

[a] Unit of effort: electroshocked 200 feet.

[b] Weight in grams.

TABLE H-6
FISH CAPTURED PER UNIT OF EFFORT, CACHE LA POUDRE RIVER, COLORADO[a/]
September and October, 1971

	Station (River Mile)																	
	53.6		51.6		41.2		36.3		26.5		17.9		9.4		0.5		0.5	
	Trap Net[b/]		Electroshock[b/]		Trap Net[b/]		Trap Net[b/]		Trap Net[b/]		Trap Net[b/]		Trap Net[b/]		Trap Net[b/]		Electroshock[b/]	
Species	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
GAME FISH																		
Rainbow trout			2	375														
Brown trout			8	2,136														
Black bullhead					6	672	5	329	3	333	1	44						
Pumpkinseed							1	2										
Largemouth bass[c/]							11	261										
FORAGE FISH																		
Brassy minnow									1	5								
River shiner											84	213	40	112				
Fathead minnow					7	20			30	82	3	6	3	7				
Longnose dace	1	8							1	11								
Creek chub					9	226			19	150	13	385	7	552				
Longnose sucker	28	5,742			16	1,479	1	66							3	560		
White sucker	4	1,356			123	15,547	309	19,525	59	9,333			143	47,292	11	3,983		
Brook stickleback											3	3						
Green sunfish					11	327	27	544	1	6	8	248	3	76	3	40		
Yellow perch							1	30	1	82	60	12,107						

TABLE H-6 (Cont)

FISH CAPTURED PER UNIT OF EFFORT, CACHE LA POUDRE RIVER, COLORADO[a]

September and October, 1971

	Station (River Mile)																	
	53.6		53.6		41.2		36.3		26.5		17.9		9.4		0.5		0.5	
	Trap Net[b]		Electroshock[b]		Trap Net[b]		Trap Net[b]		Trap Net[b]		Trap Net[b]		Trap Net[b]		Trap Net[b]		Electroshock[b]	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
ROUGH FISH																		
Carp	—	—	—	—	7	6,647	—	—	1	32	1	17	5	1,441	—	—	15	15,510
TOTAL	33	7,109	10	2,511	179	24,918	355	20,757	116	10,034	173	13,023	201	49,480	17	4,583	15	15,510

[a] Unit of effort 4 trap net days or equivalent or electroshocked 200 feet.

[b] Weight in grams.

[c] Young-of-the-year.

TABLE H-7
FISH CAPTURED PER UNIT OF EFFORT, SOUTH PLATTE RIVER, COLORADO[a]
August and September 1971

	Station (River Mile)																	
	339.2		336.5		334.9		332.3		301.7		276.7		252.5		158.1		95.4	
	Trap Nets[b]		Trap Nets[b]		Trap Nets[b]		Trap Nets[b]		Electroshock[b]		Electroshock[b]		Electroshock[b]		Electroshock[b]		Electroshock[b]	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
GAME FISH																		
Rainbow trout	1	3	3	520														
Brown trout	1	333					4	360										
Black bullhead			1	200	7	511												
Channel catfish					1	1,200												
FORAGE FISH																		
Gizzard shad															3			
River shiner											55	174	6		14	346	146	290
Red shiner									11	39			1	22	4			
Mimic shiner													3					
Fathead minnow			55	453							26	24						
Longnose dace	11	32					12	120			2	6						
Creek chub	3	61	19	804	20	369	92	1,464									48	1,583
Longnose sucker	76	4,907	30	1,890	59	2,207	76	2,748	16	22			19	444	9	923		
White sucker	21	1,995	20	2,973	61	5,965	32	5,139	8	456	6	631	3	904	19	2,177	16	1,316
Brook stickleback									2	1								
Green sunfish					3	132					1	10	6	72.5			5	83
Yellow perch			13	123	25	645												
TOTAL	113	7,331	141	6,963	176	11,029	216	10,031	37	518	80	845	38	1,442.5	49	3,446	215	3,272

---

[a] Unit of effort: Four trap net days or equivalent; or electroshocked 200 feet.

[b] Weight in grams.

APPENDIX I

DATA FOR WASTE SOURCE EVALUATIONS

TABLE I-1

SUMMARY OF ANALYTICAL DATA FOR INDUSTRIAL WASTE SOURCE EVALUATIONS
SOUTH PLATTE RIVER BASIN

Name of Industry, Address and Dates Sampled	Discharge To		Flow (mgd)	No. and Type of Sample	pH[a/] S.U.	Temp.[a/] C	Cond[a/] µmhos/cm	BOD (mg/l)	COD (mg/l)	Total Solids (mg/l)	Susp. Solids (mg/l)	Oil & Grease (mg/l)	Phenol (mg/l)
Adolph Coors Company Golden, Colorado (2/3-5/72)[b/]	Clear Creek (RM 311.1/15.3)	AVERAGE RANGE	4.79 4.13-5.42	3 Composite	5.9-7.5	9.0-14.5	400-1,950	190 118-262	205 200-213	820 800-839	17 10-24	-	-
American Smelting & Refinery Company, 495 E. 51st Avenue Denver, Colorado (9/28-29/71)	Storm sewer to South Platte River (RM 314.48)	AVERAGE RANGE	0.25 (est)	2 Grab	9.0-9.1	15-16	650-700	N.A.[c/]	25	415 400-430	45 30-60	N.A.[c/]	N.A.[c/]
City of Denver Asphalt Plant, 3600 Fox Street, Denver, Colorado (9/2[illegible]-29/71)	South Platte River (RM 316.14)	AVERAGE RANGE	0.032(est)	2 Grab	6.5-6.7	54-60	160-500	N.A.[c/]	N.A.[c/]	3,850 1,860-5,840	2,260 1,400-3,170	<1	N.A.[c/]
Continental Oil Company 5801 Brighton Blvd. Commerce City, Colorado (9/22-23/71)													
Asphalt Plant	Sand Creek (RM 312.1/1.1)	AVERAGE RANGE	0.172	8 Grab 2 Composite[d/]	7.3-7.8	25.5-28.0	950-1,400	N.A.[c/]	50	685 660-710	20	5 4-10	0.39 0.18-0.60
Refinery	Burlington Ditch	AVERAGE	0.576	8 Grabs 2 Composite[d/]	7.1-8.0	20.0-26.0	1,400-2,100	N.A.[c/]	110	1,300 1,220-1,390	60	4 3-9	<0.9 <0.01-0.18
Gates Rubber Company Denver, Colorado (8/17-19/71)													
Mississippi Avenue Outfall	South Platte River (RM 322.50)	AVERAGE RANGE	0.65(est)	9 Grab 3 Composite[e/]	7.0-8.0	27-30	725-850	[f/]	N.A.[c/]	500 430-550	28 18-42	19 14-23	N.A.[c/]
Settling Pond Outfall	South Platte River (RM 322.25)	AVERAGE RANGE	1.02	9 Grab 3 Composite[e/]	7.0-9.0	22-27	440-550	[f/]	N.A.[c/]	350 330-370	32 20-54	6 4-9	N.A.[c/]
Loveland Packing Company 1000 South Lincoln Street Loveland, Colorado (9/28-30/71)	Big Thompson River (RM 260.4/25.5)	AVERAGE RANGE	0.05	4 Grab	7.5-7.7	14.5-15.0	1,200-1,600	105 40-240	135 120-145	890 650-1,730	94 22-188	17 14-22	N.A.[c/]
Martin Marietta Littleton, Colorado (9/29-30/71)	Brush Creek (RM 341.1/2.0)	AVERAGE RANGE	0.03mg/ release	2 Grab	7.2-7.3	23-26	1,000-1,700	23 5.0-40	66	1,110 1,080-1,140	65 50-80	27	N.A.[c/]
Monfort Packing Company Greeley, Colorado (8/25-27/71)	Greeley waste-water treatment plant	AVERAGE RANGE	1.6	12 Grab[d/] 3 Composite				1,170 810-1,480	1,800	6,610 2,430-10,100	1,040 940-1,150	250	N.A.[c/]

SUMMARY OF [illegible]

SOUTH PLATTE RIVER BASIN

Name of Industry, Address and Dates Sampled	Discharge To		Flow	No. and Type of Sample	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Public Service Company, Metropolitan Denver Area (9/22-23/71)														
Arapahoe Plant Littleton, Colorado	South Platte River	AVERAGE RANGE	[illegible]	1 Grab 2 Composite	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cherokee Plant Denver, Colorado	South Platte River (RM [illegible])	AVERAGE RANGE	[illegible]	1 Grab 2 Composite	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Zuni Plant Denver, Colorado Plant Discharge	South Platte River (RM [illegible])	AVERAGE RANGE	[illegible]	1 Grab 2 Composite	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cooling Tower Blow-down Discharge	South Platte River (RM [illegible])	AVERAGE RANGE	[illegible]	1 Grab 2 Composite	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Major Cooling Water Discharge	South Platte River (RM [illegible])	AVERAGE RANGE	[illegible]	1 Grab 2 Composite	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Refinery Corporation 5800 Brighton Blvd. Commerce City, Colorado (9/17-19/71)	[illegible] (RM [illegible])	AVERAGE RANGE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Stumar Meat Company 6000 West 54th Avenue Arvada, Colorado (9/11-14/71)	[illegible]	AVERAGE RANGE	[illegible]	[illegible] 2 Composite	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Weld Co. By-Products 1012 North 11th Avenue Greeley, Colorado (9/28-29/71)	Drain to Cache la Poudre River (RM [illegible])	AVERAGE RANGE	[illegible]	1 Grab	[illegible]	12	1,000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

---

a/ Measurements made from grab samples.
b/ Data from February [illegible], 197[illegible], not used.
c/ Not analyzed.
d/ Four grab samples collected each day to make daily composite.
e/ Three grab samples collected each day to make daily composite.
f/ Samples were toxic to [illegible]; therefore, no dissolved oxygen depletion observed.
g/ Four grab samples on September 22, and seven on September 23, to make up daily composite.
h/ Five grab samples on September 22, and six on September 23, to make up daily composite.
i/ Four grab samples on September 22, and six on September 23, to make up daily composite.
j/ Twenty-four grab samples each day to make up daily composite.

TABLE I-2

SUMMARY OF INDUSTRIAL WASTE SOURCES IN THE SOUTH PLATTE RIVER BASIN[a/]

Name of Industry	Discharge To	Treatment Facilities	Remarks
Adolph Coors Company Golden	Clear Creek	Activated sludge with chlorination	Plant is organically overloaded. All wastes except those from the brewery are to be diverted to Metro facility on or about Oct, 1, 1972
Burlington Northern Railroad, Inc. Denver	South Platte River	None (See Remarks)	Spillage of oil in the refinery area is allowed to seep into the ground; these spilled oils enter the South Platte River.
Continental Oil Company Refinery and Asphalt Plant, Denver	Burlington Ditch	Oil separators and aeration units	As a result of the Project studies in 1965,[3/] it was recommended that phenol concentrations be reduced to less than 25 ppb in the discharge to Sand Creek. In Dec. 1971 asphalt wastes were diverted to refinery treatment plant which now discharges all wastes to Burlington Ditch.
Floyd Haag Sand and Gravel Company Loveland	Big Thompson River	None	Previous studies by the South Platte River Basin Project indicated this condition existed and recommended adequate treatment facilities be constructed.

TABLE I-2 (Continued)

SUMMARY OF INDUSTRIAL WASTE SOURCES IN THE SOUTH PLATTE RIVER BASIN[a]

Name of Industry	Discharge To	Treatment Facilities	Remarks
Gates Rubber Company Denver	sanitary sewer and South Platte River	Part to oil separators, part to sanitary sewers, and remainder to South Platte River	As a result of the Project studies[3] it was recommended that all wastewater be diverted to sanitarey sewers. Wastes from 5 to 6 collection sumps are still discharged to the South Platte River without treatment.
Loveland Packing Company Loveland	Big Thompson River	Aeration basin, secondary clarifier, and final polishing basin	Even though BOD and suspended solids removal efficiencies were 90 and 81 %, respectively, existing facilities did not provide treatment in accord with "best treatment" practices.
Monfort Packing Company Greeley	Greeley municipal wastewater treatment plant	Grease skimming and primary clarification	These wastes are causing gross organic overloading of the Greeley municipal waste treatment plant. The City and Company with an EPA grant, are constructing new facilities for treatment of Company wastes and the activated sludge from the present municipal plant.
Refinery Corporation Denver	Sand Creek	Oil separators, aerated lagoon, settling pond	During the 1971 survey it was observed that the discharge of oil and grease caused discoloration of Sand Creek.

TABLE I-2 (Continued)

SUMMARY OF INDUSTRIAL WASTE SOURCES IN THE SOUTH PLATTE RIVER BASIN[a/]

Name of Industry	Discharge To	Treatment Facilities	Remarks
Sigman Meat Packing Company Arvada	Process wastes go to Clear Creek Wastewater Treatment Plant	Primary treatment of process wastes	During the 1971 survey the effluent contained 1200 mg/l of BOD and 587 mg/l suspended solids.
Weld County By-Products Company, Greeley	Natural drain to Cache la Poudre River	Septic tank and then evaporation lagoon	A survey, conducted Sept. 28-29, 1971, indicated that the lagoon seepage was reaching the Cache la Poudre River.

[a/] This group does not include Great Western mill [Table I-3].

TABLE I-[illegible]

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS OF EFFLUENT DISCHARGE FROM THE GREAT WESTERN SUGAR COMPANY PLANTS

Map Key	Station Description	Date of Survey		Flow CFS	Temp. °C	Cond. µmhos/cm	pH S.U.	BOD mg/l	TOC mg/l	Alkalinity mg/l
I-2[a]	Great Western Sugar Brighton, Colorado Treatment System Effluent (RM 295.7)	12/6-10/71	AVERAGE RANGE	3.6 3.3-4.3	7.0-15.0	850-1,400	7.2-8.4	12 6.0-20	84 84-85	273 253-288
I-3[a]	Great Western Sugar Longmont, Colorado Condenser Water Effluent (RM 270.0/22.0)	12/6-10/71	AVERAGE RANGE	11.3[c]	30.0-46.0	950-1,300	8.1-9.2	46 30-54	61 25-84	213 205-225
I-3[a]	Great Western Sugar Longmont, Colorado Seepage From Lime Ponds (RM 270.0/20.8)	12/6-10/71	AVERAGE RANGE	1.0 (est)	0.0-6.5	1,400-2,200	7.5-8.4	6.7 5.0-8.0	217 210-220	498 197-661
I-4[a]	Great Western Sugar Johnstown, Colorado Water Treatment System Effluent (RM 260.4/7.0/2.8)	12/6-11/71	AVERAGE RANGE	4.4 4.25-4.75	5.0-11.0	1,050-2,550	7.3-8.5	297 267-320	205 88-430	- 140
I-5[a]	Great Western Sugar Loveland, Colorado Waste Treatment Pond Effluent (RM 260.4/22.0)	12/6-11/71	AVERAGE RANGE	11.7 10.4-14.5	0.0-5.0	520-650	7.9-8.25	13 6.0-18	56 38-75	- 130
I-5[a]	Great Western Sugar Loveland, Colorado Seepage from Lime Pond (RM 260.4/22.22/0.1)	12/6-11/71	AVERAGE RANGE	.2 (est)	3.5-10.0	1,350-1,650	7.2-7.8	51 14-100	220	658

TABLE I-1 (Continued)

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS OF EFFLUENT DISCHARGE FROM THE GREAT WESTERN SUGAR COMPANY PLANTS

Map Key	Station Description	Date of Survey		Flow cfs	Temp °C	Cond. umhos/cm	pH S.U.	BOD mg/l	TOC mg/l	Alkalinity mg/l
I-5a/	Great Western Sugar Greeley, Colorado Effluent From Serpentine Ditch (RM 249.0/4.5)	12/13-15/71	AVERAGE	7.4				615	580	-
			RANGE	7.1-7.8	20.0-24.0	1,500-1,800	6.7-7.1	480-765	400-890	-
I-6a/	Great Western Sugar Greeley, Colorado Ash Disposal and Boiler Blowdown Effluent (RM 249.0/5.2)	12/13-15/71	AVERAGE	0.9				1,230	1,190	-
			RANGE	0.5-1.5	5.0-46.0	1,650-2,150	8.1-10.2	1,650-2,150	1,160-1,210	-
I-7a/	Great Western Sugar Eaton, Colorado Condenser Water Effluent (RM 249.9/6.9/7.0)	11/29-12/3/71	AVERAGE	4.28				21	10	398
			RANGE	4.23-4.34	24.0-25.0	1,400-1,500	7.7-8.1	13-25	6-15	390-410
I-7a/	Great Western Sugar Eaton, Colorado Lime Kiln Effluent (RM 249.9/6.9/6.9)	11/29-12/3/71	AVERAGE	0.026				15	54	1,260
			RANGE	0.024-0.034	13.0-23.0	1,350-2,000	7.5-10.5	10-24	10-140	480-2,050
I-7a/	Great Western Sugar Eaton, Colorado Boiler Blowdown (RM 249.9/6.9/6.85)	11/29/12/3/71	AVERAGE	-				-	-	-
			RANGE	-	48.0-55.0	400-570	8.2-9.2	-	-	-
I-8b/	Great Western Sugar Ft. Morgan, Colorado Condenser Water Discharge (RM 196.2)	11/29-12/3/71	AVERAGE	18.4				23	11	275
			RANGE	17.0-22.3	28.0-32.0	1,250-2,150	8.2-8.6	12-34	8-16	270-280

TABLE I-3(Continued)

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS OF EFFLUENT DISCHARGE FROM THE GREAT WESTERN SUGAR COMPANY PLANTS

Map Key	Station Description	Date of Survey		Flow CFS	Temp. °C	Cond. μmhos/cm	pH S.U.	BOD mg/l	TOC mg/l	Alkalinity mg/l
I-9[b]	Great Western Sugar Sterling, Colorado Main Discharge Canal (RM 150.4/0.4)	11/29-12/3/71	AVERAGE	17.9				24	17	283
			RANGE	16.93-18.86	11.0-15.0	1,400-1,900	8.4-8.6	19-26	11-25	279-288
I-10[b]	Great Western Sugar Ovid, Colorado Lagoon Effluent (RM 94.8)	11/29-12/3/71	AVERAGE	7.47				250	130	260
			RANGE	7.33-7.69	27.0-30.0	1,500-1,750	6.3-7.1	180-290	81-170	233-304

---

a/ See Figure 3 for location.
b/ See Figure 4 for location.
c/ All values approximately the same during the survey.

TABLE I-4

SUMMARY OF BACTERIOLOGICAL ANALYSES ON SUGAR BEET MILL DISCHARGES IN THE SOUTH PLATTE RIVER BASIN

November-December, 1971

Station Description	Map Key No.[1/]	Fecal Coliform MF Count/100 ml			% of Samples >2,000	Fecal Streptococci MF Count/100 ml		
		Maximum	Log Mean	Minimum		Maximum	Log Mean	Minimum
Waste Drain for Lime and Water Pond Seepage from Great Western at Longmont (river mile 270.[illegible]).	I-3	140	[illegible]	[illegible]	-0-	53,000	7,500	2,300
Condenser Water Discharge from Great Western at Longmont (river mile 270.0/22.15/.01).	I-3	230	69	10	-0-	39,000	9,700	1,200
Effluent from Treatment System, Great Western at Johnstown (river mile 260.4/7.0/3.8).	I-4	150,000	38,000	9,000	100	350,000	290,000	270,000
Waste Drain for Lime and Mud Pond Seepage, Great Western at Loveland (river mile 260.4/22.5/0.10).	I-5	20	<9	<4	-0-	4,700	1,400	550
Waste Treatment Pond Discharge for Great Western at Loveland (river mile 260.4/22.25/0.10).	I-5	32	<8	<4	-0-	110,000	2,200	310
Condenser Water Discharge from Great Western, Eaton, Colorado (river mile 249/6.9/7.0).	I-7	120	21	4	-0-	19,000	7,900	5,200
Lime Kiln Scrubber Discharge from Great Western, Eaton (river mile 249/6.9/6.9).	I-7	900	<47	<10	-0-	58,000	4,100	220
Effluent from Great Western Serpintine Ditch (river mile 249/5.4-249/4.5).	I-6	780,000	210,000	130,000	100	8,300,000	>2,400,000	1,000,000
Effluent from Ash Disposal and Boiler Blowdown System (river mile 249/5.4-249/5.2).	I-6	710,000	>60,000	310,000	100	12,000,000	>3,100,000	100,000

TABLE I-4 continued
SUMMARY OF BACTERIOLOGICAL ANALYSES ON SUGAR BEET MILL DISCHARGES IN THE SOUTH PLATTE RIVER BASIN
November-December, 1971

Station Description	Map Key No. a/	Fecal Coliform MF Count/100 ml			% of Samples > 2,000	Fecal Streptococci MF Count/100 ml		
		Maximum	Log Mean	Minimum		Maximum	Log Mean	Minimum
Water Supply Intake at Diversion Point - Great Western Brighton (river mile 295.70).	I-2	>6,000	>330	140	20	5,400	818	100
Condenser Water Discharge from Great Western at Brighton (river mile 295.70).	I-2	>6,000	>110	20	20	8,700	1,700	500
Condenser Water only for Great Western at Fort Morgan (river mile 196.20)	I-8	48	<10	<4	-0-	13,000	1,900	180
Main Discharge Canal from the Sterling Great Western Plant (river mile 150.20/.4).	I-9	810	370	150	-0-	3,600,000	>560,000	>100,000
Effluent from Transport Water Treatment System at Sterling (river mile 150.20/.40/.30).	I-9	6,300	3,700	900	80	7,900,000	>1,000,000	>100,000
Condenser Water Discharge from Great Western Mill at Sterling (river mile 150.20/.70).	I-9	110	<42	28	-0-	60,000	5,500	490
Lagoon Effluent from Great Western Mill at Ovid, Colorado (river mile 94.94/.20).	I-10	4,300,000	>1,900,000	>600,000	100	>10,000,000	>5,000,000	>1,000,000

---

a/ Map Key No. I-2 to I-7 shown on Figure 3; I-8 to I-10 shown on Figure 4.

TABLE I-5

SUMMARY OF WASTE TREATMENT FOR THE GREAT WESTERN SUGAR PLANTS IN THE SOUTH PLATTE RIVER BASIN[a/]
NOVEMBER-DECEMBER 1971

Plant Location	Receiving Water	Present Treatment	Remarks
Brighton (RM 295.7)	South Platte River	The mill recycles all flume water. Treatment of flume water consists of screening, primary sedimentation, two secondary settling basins in series. The water is then reused. Muds are removed from the settling ponds periodically and placed on periphery for drying. Lime mud wastes are discharged into a 6-8 acre pond adjacent to South Platte River. A surge pond (20 acres) receives excess flume water from recycle pond.	1. Adequate BOD and suspended solids removals were accomplished during the 1971-72 campaign. 2. A three-fold rise in water temperature existed between McCann Ditch water source and treated mill effluent. However, no significant temperature change occurred in the South Platte River. 3. According to company data, nutrients in the effluent were high. Total phosphates and inorganic nitrogen ranged from 0.05-0.25 mg/l and 15.7-17.7 mg/l, respectively. The water supply contributes the major portion of these nutrients. 4. The lime mud pond is located close to the South Platte River and represents a potential pollution problem in case of dike failure. 5. The Company should be commended for water conservation and the significant improvements in waste treatment attained since the 1966 conference.
Johnstown (RM 260.4/7.0/2.8)	Little Thompson River	General plant wastes flow to an aeration basin. A third aerator was being installed at the time of the evaluation. Sludge from the aeration basin flows to a settling chamber from which settled sludge will be returned to the aeration basin. The aeration pond effluent flows to the stabilization ponds.	1. At time of visit, construction on aeration basin caused wastes to be bypassed to the stabilization ponds. Company officials anticipate 80 percent removal when the facilities are completed. 2. The Johnstown factory discharge caused violation of the Colorado water quality standards.

TABLE I-5 (Continued)

SUMMARY OF WASTE TREATMENT FOR THE GREAT WESTERN SUGAR PLANTS IN THE SOUTH PLATTE RIVER BASIN[a]
NOVEMBER-DECEMBER 1971

Plant Location	Receiving Water	Present Treatment	Remarks
Johnstown (Continued)		Condenser waters are conveyed directly to the stabilization ponds. Acid boilouts, chemical spill, and kiln scrubber overflow are conveyed to a nonoverflow chemical pond.	
Longmont (RM 270.0/22.0)	St. Vrain Creek	Recirculation of flume waters with 33 percent diverted into primary and secondary lime settling basins. Overflow from the settling basin mixes with recycled flume water. Excess overflow is discharged to the anaerobic surge basin. Settled lime muds are sluiced to a nonoverflowing lime basin. Condenser water receives no treatment.	1. The mill discharged 2,520 lb /day of BOD (0.80 lb /ton of sugar beets sliced) to St. Vrain Creek. This contributed in depressing the dissolved oxygen levels to below the standard of 3.0 mg/1. 2. The condenser water discharge raised the temperature of St. Vrain Creek as much as 13°C. 3. Waste loads from a) Longmont Great Western Mill and b) Longmont treatment plant caused violation in St. Vrain Creek of basic standards applicable to all waters of the State.
Loveland (RM 260.4/22.0)	Big Thompson River	Mechanical clarification of flume waters with the effluent recycled. Clarifier muds are discharged to a non-overflow 40-acre pond. Condenser waters are treated by two cooling ponds in series and are the only discharges to the Big Thompson River. Lime wastes are discharged to a non-overflowing, 20-acre pond.	1. The effluent quality achieved during the 1971-72 campaign was 0.22 lb BOD/ton of beets sliced. Treatment of surface discharges was adequate. 2. Excessive seepage (0.13 mgd) from wastewater ponds was noted during the inplant evaluation in December. 3. Lime mud BOD levels from the lime mud ponds were higher (100 mg/1) than from main discharge (65 mg/1).

TABLE I-5 (Continued)

SUMMARY OF WASTE TREATMENT FOR THE GREAT WESTERN SUGAR PLANTS IN THE SOUTH PLATTE RIVER BASIN[a]
NOVEMBER-DECEMBER 1971

Plant Location	Receiving Water	Present Treatment	Remarks
Eaton (RM 249.0/6.9/7.0)	Eaton Draw	Flume water has closed recirculation-screened to primary settlers to secondary settlers back to plant. Surge ponds provided for overflow. Lime mud goes to a separate pond with no overflow. Condenser water goes to a spray pond with constant overflow. Lime kiln scrubber and boiler blowdown go to Eaton Draw.	1. Adequate treatment of surface discharges is being provided at this plant. A plant evaluation showed that about 500 lb BOD/day (0.2 lb/ton) were discharged. 2. Suspended solids discharged during the 1971-72 campaign exceeded the limits set by Refuse Act Permit Program for this plant.
Greeley (RM 5.25)	Cache la Poudre River	Separate waste ponds for lime muds. Boiler blowdown and the ashes and unburned coal and coke residues from the boilers and lime kiln are discharged to the river (RM 5.25). Some condenser water is returned to water supply pond. Waste flume waters, excess condensates, leaks, spills, boilouts and miscellaneous wastes go to a serpentine shaped ditch which discharges to the river at RM 4.3.	1. The discharges from the mill in combination with those from the Greeley treatment plant cause gross pollution in the lower reach of the Cache la Poudre River. The company has publicly stated that adequate treatment will be provided by the start of the 1972-73 campaign if the plant stays in operation. 2. The December 13-15, 1971, survey findings indicate that Great Western Mill is discharging about 25,000 lb BOD/day to the Cache la Poudre River (10.7 lb of BOD/ton of sliced beets). 3. Fecal coliform density (log mean) was 210,000/100 ml during the survey.
Fort Morgan (RM 196.2)	South Platte River	Mechanical clarification of flume waters with the effluent recycled. Clarifier muds are discharged to mud ponds. The mud pond overflow mixes with recycled flume water. Lime wastes are discharged to the non-overflowing lime pond, and acid wastes are discharged to the non-overflowing acid waste pond. Condenser water receives no treatment.	1. Effluent sampling data indicate a substantial reduction in the waste loads discharged by the plant since 1963. 2. However, company data showed discharges during 1971-72 campaign to exceed 26,000 lb BOD/day (7.4 lb / ton of beets sliced). The possible cause of high BOD levels of the condenser water were being investigated by company officials.

TABLE I-3 (Continued)

SUMMARY OF WASTE TREATMENT FOR THE GREAT WESTERN SUGAR PLANTS IN THE SOUTH PLATTE RIVER BASIN[a/]
NOVEMBER-DECEMBER 1971

Plant Location	Receiving Water	Present Treatment	Remarks
Sterling (RM 150.4)	South Platte River	A "partial" recycle flume water system is used. About 25 percent of the flume water, after settlement in the mud ponds, is treated by aerated lagoons and settling basins. The settled muds are hauled away. Lime wastes are discharged to the non-overflowing lime pond; acids and caustic boil-outs are discharged to a non-overflowing pit. Condenser water receives no treatment.	The EPA data indicated 0.9 lbs BOD/ton of beets was discharged during the survey. Company data show that during the 1971-72 campaign the BOD ranged from 0.23-4.7 lbs/ton.
Ovid (RM 94.9)	South Platte River	Separate ponds for lime muds. Flume waters, condenser waters and other plant wastes, after screening, are passed through two settling ponds (approximately 750 feet by 75) and then discharged to the South Platte River.	Company has publicly stated they plan to install necessary treatment by the start of the 1973-74 campaign.

---

a/ Individual reports on each Great Western Company Mill are contained in the report entitled "Technical Appendix on Industrial Waste Source Evaluations", except for the Greeley and Ovid Mills which are discussed in the reports entitled "Effects of Waste Discharges on Water Quality of the Cache la Poudre and South Platte Rivers - Greeley Area" and "Investigation of the Effects of the Waste Discharges from the Great Western Sugar Mill at Ovid, Colorado on Water Quality Conditions in the South Platte River," respectively.

b/ The Region VIII, Permits Program, has set special permit conditions for each Great Western plant in the basin.

c/ An effluent containing 0.5 lbs each of BOD and suspended solids or less is achievable by the installation of the best practicable control technology currently available for the sugar beet industry.

TABLE I-6

SUMMARY OF ANALYTICAL DATA FOR MUNICIPAL WASTE SOURCE EVALUATIONS - SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a]	Facility and Dates Sampled		Flow MGD	BOD		Suspended Solids		Total Solids		Chlorine Residual (mg/1)
				Influent (mg/1)	Effluent (mg/1)	Influent (mg/1)	Effluent (mg/1)	Influent (mg/1)	Effluent (mg/1)	
	South Platte River Main Stem									
M-1	Littleton, City of (September 20-24) (RM 327.6)	AVERAGE RANGE	5.2 4.8-5.6	158 150-170	33 30-40	353 140-710	40[c]	885 830-1,000	650 590-690	0.9
M-2	Englewood, City of (September 20-24) (RM 325.1)	AVERAGE RANGE	8.6 8.2-8.8	115 70-160	87 80-90		135 120-150	895 880-910	877 870-900	0.4
M-3	South Lakewood Sanitation District (August 17-20) (RM 318.9)	AVERAGE RANGE	1.8 1.7-1.8	103 100-110	33 13-60	113 90-150	60 40-90	717 640-820	600 540-660	0.8
	Clear Creek Drainage									
M-4	Wheatridge Sanitation District (February 3-5) (RM 311.1/7.7)	AVERAGE RANGE	2.1 2.1-2.2	328 213-532	135 118-162	171 126-227	87 54-116	872 630-1,165	611 601-622	<0.1
M-5	Clear Creek Valley Sanitation District (August 11-14) (RM 311.1/7.0)	AVERAGE RANGE	2.5 2.4-2.6	285 220-350	17 15-19	143 100-170	<40 <20-70	973 960-990	860 840-870	0.8
M-6	Arvada, City of (August 11-14) (RM 311.1/6.7/0.2)	AVERAGE RANGE	1.09 1.06-1.10	190 150-230	29 15-44	147 90-190	50 40-60	693 670-720	600 590-620	1.4

TABLE I-6 (Continued)

SUMMARY OF ANALYTICAL DATA FOR MUNICIPAL WASTE SOURCE EVALUATIONS - SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a]	Facility and Dates Sampled		Flow MGD	BOD Influent (mg/l)	BOD Effluent (mg/l)	Suspended Solids Influent (mg/l)	Suspended Solids Effluent (mg/l)	Total Solids Influent (mg/l)	Total Solids Effluent (mg/l)	Chlorine Residual (mg/l)
	Clear Creek Drainage									
M-7	Baker Water and Sanitation District (August 11-14) (RM 311.1/3.4)	AVERAGE RANGE	1.00 0.97-1.03	330[b]	70[b]	287 140-540	40 30-50	1,880 1,300-2,700	1,170 1,190-1,200	2.1
	South Platte River Main Stem									
M-8	Metropolitan Denver Sanitation District (August 1-9) (RM 312.2)	AVERAGE RANGE	116 104-124	187 160-210	31 10-100	95 50-140	122 33-240	[illegible] 780-890	745 660-830	<0.2
M-10	South Adams Sanitation District (January 31-February 2) (RM 306.7)	AVERAGE RANGE	1.8 1.8-1.9	223 200-241	62 50-70	236 89-400	145 48-298	1,380 1,190-1,620	1,160 1,110-1,190	2.3
M-11	Brighton, City of (August 31-September 2) (RM 295.8)	AVERAGE RANGE	1.3 1.2-1.4	156 100-230	53 50-60	175 160-200	80 60-100	1,880 1,810-1,960	1,550 1,500-1,590	0
M-12	Fort Lupton, City of (August 31-September 2) (RM 287.6)	AVERAGE RANGE	0.032[b] -		30 20-40		116 80-140		1,660 1,640-1,670	No Facility
	St. Vrain River Drainage									
M-13	Boulder - Pearl Street (August 17-20) (RM 270.0/17.4/21.3)	AVERAGE RANGE	4.0 3.6-4.3	140 130-170	48 30-75	130 120-150	36 18-50	925 750-1,060	355 220-370	1.3

TABLE I-6 (Continued)

SUMMARY OF ANALYTICAL DATA FOR MUNICIPAL WASTE SOURCE EVALUATIONS - SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a]	Facility and Dates Sampled		Flow MGD	BOD		Suspended Solids		Total Solids		Chlorine Residual (mg/1)
				Influent (mg/1)	Effluent (mg/1)	Influent (mg/1)	Effluent (mg/1)	Influent (mg/1)	Effluent (mg/1)	
	St. Vrain River Drainage									
M-14	Boulder - 75th Street (August 17-20) (RM 270.0/17.4/17.8)	AVERAGE	7.8	173	41	120	<30	497	433	2.8
		RANGE	7.7-8.0	160-190	16-75	110-130	<20-40	400-560	370-490	
M-15	Lyons, City of (August 31-September 2) (RM 270.0/34.3)	AVERAGE	0.05		20[c]		65		1,030	1.5[b]
		RANGE	-				50-80		200-1,850	
M-16	Longmont, City of (January 31-February 3) (RM 270.0/22.3)	AVERAGE	3.7	188	57	229	65	925	1,047	-
		RANGE	3.4-4.1	172-218	20-78	154-372	36-104	811-1,080	781-1,540	-
	Big Thompson River Drainage									
M-17	Loveland, City of (January 31-February 2) (RM 260.4/24.5)	AVERAGE	2.7	174	62	260	53	933	679	.7
		RANGE	2.6-2.8	148-210	60-66	232-318	46-64	839-1,050	671-692	-
	Cache la Poudre River Drainage									
M-18	Fort Collins, City of (Plant #1) (January 31-February 2) (RM 249.0/44.1)	AVERAGE	3.9	193	59	454	110	1,164	495	.4
		RANGE	3.6-4.	185-200	52-66	202-940	41-240	872-1,440	378-586	-
M-19	Fort Collins, City of (Plant #2) (RM 249.0/40.2) (January 31-February 2)	AVERAGE	3.9	218	39	346	30	717	339	.9
		RANGE	3.4-4.1	200-230	35-42	324-376	21-42	609-793	315-353	-

TABLE I-6 (Continued)

SUMMARY OF ANALYTICAL DATA FOR MUNICIPAL WASTE SOURCE EVALUATIONS - SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

				BOD		Suspended Solids		Total Solids		
Map Key[a/]	Facility and Dates Sampled		Flow MGD	Influent (mg/l)	Effluent (mg/l)	Influent (mg/l)	Effluent (mg/l)	Influent (mg/l)	Effluent (mg/l)	Chlorine Residual (mg/l)
M-20	Eaton, Colorado (November 30-December 2) (RM 249.0/6.9/6.6)	AVERAGE	0.16	-	72	-	-	-	-	-
		RANGE	0.15-0.17	-	46-100	-	-	-	-	-
M-21	Greeley, City of (January 26-29) (RM 249.0/5.3)	AVERAGE	7.0	493	282	450	356	1,180	894	Trace
		RANGE	6.9-7.1	480-510	200-355	376-514	168-506	1,050-1,270	811-957	-
	Monfort Meat Packing Company discharges to City of Greeley plant (January 26-28)	AVERAGE	1.7	-	1,290	-	1,210	-	3,570	-
		RANGE	1.7-1.8	-	1,160-1,400	-	616-1,560	-	2,840-3,980	-
	South Platte River Main Stem									
M-22	Fort Morgan, City of (January 26-29) (RM 195.2)	AVERAGE	2.6	697	190	834	94	3,820	2,900	No Facility
		RANGE	2.3-2.8	600-790	160-220	304-1,570	66-129	3,380-4,070	2,860-2,950	-
	American Beef Packers Co., discharges to City of Fort Morgan plant (January 26-28)	AVERAGE	1.0(est)	-	1,640	-	12,600	-	31,400	-
		RANGE		-	1,100-2,700	-	3,140-29,840	-	7,630-53,740	-
M-23	Brush, City of (January 26-29) (RM 185.6)	AVERAGE	1.11	860	140	1,118	45	2,256	773	No Facility
		RANGE	1.07-1.21	610-1,320	100-220	535-1,580	29-74	1,200-3,320	698-920	-
	Sigman Meat Packing Co., discharges to City of Brush plant (January 26-28)	AVERAGE	0.6	-	1,140	-	1,080	-	2,280	-
		RANGE	0.5-0.7	-	1,030-1,200	-	664-1,780	-	1,720-3,220	-

TABLE I-6 (Continued)

SUMMARY OF ANALYTICAL DATA FOR MUNICIPAL WASTE SOURCE EVALUATIONS - SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a]	Facility and Dates Sampled		Flow MGD	BOD Influent (mg/1)	BOD Effluent (mg/1)	Suspended Solids Influent (mg/1)	Suspended Solids Effluent (mg/1)	Total Solids Influent (mg/1)	Total Solids Effluent (mg/1)	Chlorine Residual (mg/1)
M-24	Sterling, City of (January 26-29) (RM 148.6)	AVERAGE	2.53	903	288	2,230	269	5,650	2,830	<0.1
		RANGE	2.29-2.74	800-970	175-480	1,200-3,400	112-512	4,110-6,460	2,520-3,270	-
	Sterling Packing Co., discharges to City of Sterling plant (January 26-28)	AVERAGE	0.5	-	1,270	-	870	-	3,550	-
		RANGE	0.3-0.8	-	910-1,800	-	250-1,610	-	2,840-4,040	-
M-25	Julesburg, City of (September 28-October 1) (RM 86.9)	AVERAGE	0.20	155	45	690[b]	60[b]	1,410[b]	1,470[b]	No Facility
		RANGE	0.19-.21	140-180	30-80	-	-	-	-	-

---

a/ M-1 through M-10 see Figure 2.
M-11 through M-21 see Figure 3.
M-22 through M-25 see Figure 4.

b/ Based on one days data.

c/ All values the same.

TABLE 1-7
SUMMARY OF BACTERIOLOGICAL ANALYSES ON MUNICIPAL WASTE TREATMENT PLANT DISCHARGES IN THE SOUTH PLATTE RIVER BASIN
August and September, 1971

Station Description	Dates	Total Coliform MF Count/100 ml Maximum	 Log Mean	 Minimum	Fecal Coliform MF Count/100 ml Maximum	 Log Mean	 Minimum
Baker Waste Water Treatment Plant	8/11(3),12(3), 13(2)	830	<66	8	<20	<7	<2
Brighton Waste Water Treatment Plant	9/27(1),28(2), 29(1)	8,900,000	>2,700,000	>800,000	1,900,000	860,000	340,000
Boulder-East Pearl Waste Water Treatment Plant	8/17(3),18(3), 19(2)	1,300	290	120	62	16	2
Boulder-75th Street Waste Water Treatment Plant	8/17(3),18(3), 19(2)	>80,000	>1,600	170	>6,000	>40	<2
Fort Lupton - North Waste Water Treatment Plant	9/27(1),28(2), 29(1)	190,000	43,000	2,700	18,000	8,200	1,900
Fort Lupton - South Waste Water Treatment Plant	9/27(1),28(2), 29(1)	77,000	40,000	23,000	33,000	8,900	3,100
Longmont Waste Water Treatment Plant	9/27(1),28(2), 29(1)	550,000	800	9	8,400	34	<4
Lyons Waste Water Treatment Plant	9/27(1),28(2), 29(2)	500,000	>66,000	>8,000	55,000	6,100	730
Loveland Waste Water Treatment Plant	8/23(2),24(3), 25(2)	180,000	17,000	1,800	1,000	210	32

TABLE I-7 continued
SUMMARY OF BACTERIOLOGICAL ANALYSES ON MUNICIPAL WASTE TREATMENT PLANT DISCHARGES IN THE SOUTH PLATTE RIVER BASIN
August and September, 1971

Station Description	Dates 1971	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
Littleton Waste Water Treatment Plant	9/21(3),22(3),23(2)	100,000	9,800	170	2,600	<96	<10
Englewood Waste Water Treatment Plant	9/21(3),22(3),23(2)	>800,000	>15,000	<10	6,000	<240	<10
Denver Metro Waste Water Treatment Plant	8/2(5),3(6),4(7)5(3),6(7),31(1),9/2(1)	14,000,000	130,000	6,600	430,000	<4,700	230
Coors Waste Water Treatment Plant	9/21(3),22(3),23(2)	>800,000	>330,000	73,000	330,000	>19,000	1,200
Clear Creek Valley Waste Water Treatment Plant	8/11(3),12(3),13(2)	6,600,000	87,000	1,100	57,000	380	6
Arvada Waste Water Treatment Plant	8/11(3),12(3),13(2)	53,000	<1,600	<100	400	<39	16
Wheat Ridge Waste Water Treatment Plant	8/11(3),12(3),13(2)	220,000	54,000	7,600	160,000	700	82
Lakewood Waste Water Treatment Plant	8/17(3),18(2),19(3)	340,000	>1,800	30	48,000	<140	<4
South Adams Waste Water Treatment Plant	8/17(3),18(2),19(3)	52,000	650	19	3,900	<48	<4

TABLE I-7 continued
SUMMARY OF BACTERIOLOGICAL ANALYSES ON MUNICIPAL WASTE
TREATMENT PLANT DISCHARGES
IN THE SOUTH PLATTE RIVER BASIN
August and September, 1971

Station Description	Dates 1971	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
Ft. Collins Waste Water Treatment Plant No. 1	8/23(2),24(3), 25(3)	71,000	20,000	1,600	3,200	<240	18
Ft. Collins Waste Water Treatment Plant No. 2	8/23(3),24(3), 25(1)	1,900,000	>10,000	9	670,000	>1,200	<10
Greeley Waste Water Treatment Plant	8/23(3),24(3), 25(2)	>800,000	>32,000	2,700	550,000	4,200	81

No. in ( ) indicates number of samples collected that date.

TABLE I-8
SUMMARY OF BACTERIOLOGICAL ANALYSES OF SELECTED MUNICIPAL
WASTE TREATMENT PLANT DISCHARGES
SOUTH PLATTE RIVER BASIN SURVEY
November-December, 1971

Station Description	Fecal Coliform MF Count/100 ml			% of Samples	Fecal Streptococci MF Count/100 ml		
	Maximum	Log Mean	Minimum	>2,000	Maximum	Log Mean	Minimum
Outfall from Longmont Waste Water Treatment Plant to St. Vrain Creek (river mile 270.0/22.5).	1,100,000	14,000	20	80	ONE	VALUE -	4,600
Eaton Waste Water Treatment Plant Effluent (river mile 249/6.9/6.6).	>60,000	>12,000	5,900	100			
Effluent from Greeley Waste Water Treatment Plant (river mile 249/5.3).	770,000	46,000	<1,000	60	930,000	>100,000	<1,000
Julesburg, Colorado Waste Water Treatment Plant Effluent (river mile 86.9).	310,000	160,000	53,000	100			

TABLE I-9

SUMMARY OF BACTERIOLOGICAL ANALYSES ON MUNICIPAL WASTE TREATMENT PLANT DISCHARGES IN THE SOUTH PLATTE RIVER BASIN
JANUARY-FEBRUARY, 1972

Station Description	Dates of Samples	Total Coliform MF Count/100 ml			Fecal Coliforms MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
Coors Effluent	2/2(1), 3(3), 4(2)	110,000	5,400	200	2,600	120	4
Wheatridge STP Effluent	2/2(1), 3(3), 4(2)	2,700,000	>46,000	50	88,000	>910	4
South Adams STP Effluent	1/31(3), 2/1(2), 2(2)	4,000	32	<4	30	<9	<4
Longmont STP Effluent	1/31(2), 2/1(2), 2(2)	11,000,000	8,500,000	6,600,000	1,200,000	840,000	470,000
Loveland STP Effluent	1/31(2), 2/1(2), 2(2)	2,300,000	110,000	<100	22,000	<3,700	<100
Fort Collins STP Effluent - Plant No. 1	1/31(2), 2/1(2), 2(2)	430,000	140,000	59,000	2,400	860	300
Fort Collins STP Effluent - Plant No. 2	1/31(2), 2/1(2), 2(2)	5,000	<630	70	<1,000	<34	<4
Greeley STP Effluent	1/26(2), 27(2), 28(2)	25,000,000	12,000,000	6,000,000	2,500,000	1,300,000	940,000
Fort Morgan STP Effluent	1/26(2), 27(2), 28(2)	9,000,000	3,600,000	1,700,000	720,000	510,000	310,000
Brush STP Effluent	1/26(2), 27(2), 28(2)	28,000,000	7,800,000	960,000	11,000,000	3,800,000	140,000
Sterling STP Effluent	1/26(2), 27(2), 28(2)	2,700,000	1,200,000	710,000	3,000,000	170,000	63,000

Number in parentheses indicates the number of samples collected that date.

TABLE I-10

SUMMARY OF FINDINGS
MUNICIPAL WASTE SOURCE EVALUATIONS IN THE SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a/]	Name of Facility[b/]	Discharge To	BOD Removal Efficiency (Percent)	Disinfection	Findings
M-1	Littleton (RM 327.6)	South Platte River	76	Adequate	The average BOD removal efficiency was below the minimum established by the State of Colorado. Disinfection was adequate except on one occasion.
M-2	Englewood (RM 325.1)	South Platte River	See Findings	Inadequate	This plant was under expansion during the survey. Expanded capacity of the plant will be 12 mgd.
M-3	South Lakewood Sanitation District (RM 318.9)	South Platte River	69	Adequate	1. The average BOD removal efficiency was below the minimum established by the State of Colorado because of hydraulic overloading. 2. The plant is presently under expansion to a design capacity of 1.8 mgd (the flow observed at the time of the survey).
M-4	Wheatridge Sanitation District (RM 311.1/7.70)	Clear Creek	54	Inadequate	1. The average BOD removal efficiency was below the minimum established by the State of Colorado. 2. Plant operation is poor and additional operator training is required. 3. The entire flow of this plant could be diverted into the Metro system.

TABLE I-13 (Continued)

SUMMARY OF FINDINGS
MUNICIPAL WASTE SOURCE EVALUATIONS IN THE SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a/]	Name of Facility[b/]	Discharge To	BOD Removal Efficiency (Percent)	Disinfection	Findings
M-5	Clear Creek Valley Sanitation District (RM 311.1/7.0)	Clear Creek	94	Inadequate	This plant treats only 2.5 mgd and the feasibility of continued operation is questionable.
M-6	Arvada (RM 311.1/6.7/0.2)	Ralston Creek	86	Adequate	1. Operation and maintenance has improved since the studies of the South Platte River Basin Project. 2. Treatment is adequate; however, only 25 percent of wastes from Arvada are treated by the plant (2.5 mgd are diverted to Metro). The feasibility of continued operation is questionable.
M-7	Baker Water and Sanitation District (RM 311.1/3.40)	Clear Creek	79	Adequate	1. Operation and maintenance has improved since the studies by the South Platte River Basin Project. 2. Continued operation is questionable. Approximately half of the flows received are treated (0.8 mgd are diverted to Metro). 3. During the survey, an excessive amount of chlorine was being added to the effluent to reduce the number of coliform bacteria. This practice is considered wasteful and could have possible detrimental effects on the receiving waters.

TABLE I-10 (Continued)

SUMMARY OF FINDINGS
MUNICIPAL WASTE SOURCE EVALUATIONS IN THE SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a]	Name of Facility[b]	Discharge To	BOD Removal Efficiency (Percent)	Disinfection	Findings
M-8	North Denver Wastewater Treatment Plant	Metro	29		Primary wastewater treatment facility with total effluent flow pumped to the Metro plant.
M-9	Metropolitan Denver Sewage Disposal District (RM 312.3)	South Platte River	75	Inadequate	1. Adequate treatment was not being provided by the Metro plant for BOD and suspended solids removal. Including removals at the Northside plant, BOD removals for Denver Metro ranged from 63 percent to 96 percent on a daily average and were below the State requirement of 80 percent removal 20 percent of the time. Suspended solids removal ranged between 39 percent and 95 percent. Removals were highest during the weekend when the overloading conditions were minimal. 2. The Denver Metro plant is overloaded hydraulically and organically. The plant is designed for 117 mgd. Peak flows of 180 mgd were recorded during the survey. The average BOD loading observed (182,000 lb/day) was 110 percent of the design loading. Four of the twelve aeration basins are being used for sludge digestion instead of wastewater treatment.

TABLE I-10 (Continued)

SUMMARY OF FINDINGS
MUNICIPAL WASTE SOURCE EVALUATIONS IN THE SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a]	Name of Facility[b]	Discharge To	BOD Removal Efficiency (Percent)	Disinfection	Findings
M-9	Metropolitan Denver (Continued)				3. Sludge handling capacity at Metro is a problem; this inadequacy affects plant performance in producing a satisfactory effluent. 4. Adequate disinfection was not provided, as fecal coliform bacteria in the effluent ranged from 230-430,000 organisms/100 ml. 5. The Metro and Northside plants are under different management, making effective operation difficult. The Northside plant effluent constitutes the major input to Metro and operational difficulties at Northside affect Metro significantly.
M-10	South Adams Water and Sanitation District (RM 306.7)	South Platte River	73	Adequate	1. The plant did not provide adequate BOD and suspended solids removal. The low removal efficiencies were due to a high carry-over of suspended solids in the effluent. 2. During the survey, an excessive amount of chlorine was being added to the effluent to reduce the number of coliform bacteria. This practice is considered wasteful and could have possible detrimental effects on the receiving water.

TABLE I-10 (Continued)

SUMMARY OF FINDINGS
MUNICIPAL WASTE SOURCE EVALUATIONS IN THE SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a/]	Name of Facility[b/]	Discharge To	BOD Removal Efficiency (Percent)	Disinfection	Findings
M-11	Brighton (RM 295.8)	South Platte River	68 (see findings)	Inadequate	The Plant did not conform to criteria for BOD removal. It was under expansion at the time of the survey. 2. Laboratory facilities have been provided but are not used to provide the most efficient operation of the plant.
M-12	Fort Lupton (RM 287.6)	South Platte River	--	Adequate	Treatment is adequate
M-13	Boulder - East Pearl Street Plant (RM 270.0/17.4/21.3)	Boulder Creek	65	Adequate	1. The plant did not conform to criteria for BOD removal. Digestors were out of oper- and sludge was being stored in the primary clarifier. 2. Operational changes were planned to improve BOD and suspended solids removals.
M-14	Boulder - 75th Street Plant (RM 270.0/17.4/17.8)	Boulder Creek	77	Adequate	1. The plant did not conform to criteria for BOD removal. 2. Expansion should correct problems observed during the survey. Plant will be expanded to 15.6 mgd. 3. Infiltration in the older portion of the collection system contributes to hydraulic overloading.

TABLE I-11 (Continued)

SUMMARY OF FINDINGS
MUNICIPAL WASTE SOURCE EVALUATIONS IN THE SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a]	Name of Facility[b]	Discharge To	BOD Removal Efficiency (Percent)	Disinfection	Findings
M-15	Lyons (RM 270.0/34.3)	St. Vrain Creek	--	Adequate	1. The BOD and suspended solids loadings cause no adverse effect on St. Vrain Creek. 2. Disinfection procedures are adequate when equipment is operating.
M-16	Longmont (RM 270.0/22.3)	St. Vrain Creek	63	None	1. The plant did not conform to criteria for BOD removal. 2. Chlorination facilities were not in operation during the survey. 3. The ABF plant was opeating as a high-rate trickling filter because of operational problems with the filter. 4. The effluent from the facility was essentially the entire flow of St. Vrain Creek because of an upstream diversion. 5. The design capacity is limited by pumping capability. At peak flows, primary clarifier effluent overflows into the outfall line.
M-17	Loveland (RM 260.4/24.5)	Big Thompson River	63	Inadequate	1. Plant did not conform to criteria for BOD removal. 2. The discharge from the plant results in water quality degradation of the Big Thompson River.

TABLE I-10 (Continued)

SUMMARY OF FINDINGS
MUNICIPAL WASTE SOURCE EVALUATIONS IN THE SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a]	Name of Facility[b]	Discharge To	BOD Removal Efficiency (Percent)	Disinfection	Findings
M-18	Fort Collins Plant No. 1 (RM 249.0/44.1)	Cache la Poudre River	70	Inadequate	1. Plant did not conform to criteria for BOD removal. 2. Water quality degradation occurred downstream from the effluent discharge.
M-19	Fort Collins Plant No. 2 (RM 249.0/40.2)	Cache la Poudre River	82	Adequate	1. Plant met or exceeded all State requirements. 2. Water quality degradation occurred downstream from the effluent discharge.
M-21	Greeley (RM 249.0/5.3)	Cache la Poudre River	43	Inadequate	Average BOD removal efficiency was below the minimum established by the State of Colorado due to gross organic overloading of the plant. The major portion of the organic load is received from the Monfort of Colorado packing plant.
M-22	Fort Morgan (RM 195.2)	South Platte River	72	None	1. Plant did not conform to criteria for BOD removal because of high organic waste loads from American Beef Packers, Inc. 2. Plant is under expansion.

TABLE I-10 (Continued)

SUMMARY OF FINDINGS
MUNICIPAL WASTE SOURCE EVALUATIONS IN THE SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a/]	Name of Facility[b/]	Discharge To	BOD Removal Efficiency (Percent)	Disinfection	Findings
M-23	Brush (RM 185.6)	South Platte River	84	None	1. Plant meets minimum requirements of State for BOD removal, but the effluent load to the stream is high. 2. Plant is not providing effluent chlorination. 3. The Sigman Meat Company contributes more than 70 percent of the BOD load and more than 50 percent of the suspended solids load received by the Brush plant. Grease from the meat company also causes mechanical difficulties at the plant.
M-24	Sterling (RM 148.6)	South Platte River	67	Inadequate	1. Average BOD removal efficiency was below the minimum established by the State of Colorado, due to organic overloading. 2. The Sterling Beef Packing Company contributes the major portion of the waste load to the Sterling plant and overloads it organically. 3. Laboratory analyses preformed at the Sterling plant are not adequate.

TABLE I-10 (Continued)

SUMMARY OF FINDINGS
MUNICIPAL WASTE SOURCE EVALUATIONS IN THE SOUTH PLATTE RIVER BASIN
AUGUST 1971-FEBRUARY 1972

Map Key[a/]	Name of Facility[b/]	Discharge To	BOD Removal Efficiency (Percent)	Disinfection	Findings
M-25	Julesburg (RM 86.9)	South Platte River	69	Inadequate	1. The plant did not conform to criteria for BOD removal. 2. The plant receives very little operation and maintenance.

[a/] Unless noted as sanitation districts, facilities are municipally operated.

[b/] Individual reports are contained in "Technical Appendix on Municipal Waste-Source Evaluation, Water Quality Investigations in the South Platte River Basin, Colorado, 1971-72" with the exception of Metropolitan Denver Sewer Disposal District No. 1 and Greeley Wastewater Treatment Plant which are discussed in reports entitled "Effects of Waste Discharges on Water Quality of the South Platte River-Denver Metropolitan Area, June 1972" and "Effects of Waste Discharges on Water Quality of the Cache la Poudre and South Platte Rivers-Greeley Area, February 1972."